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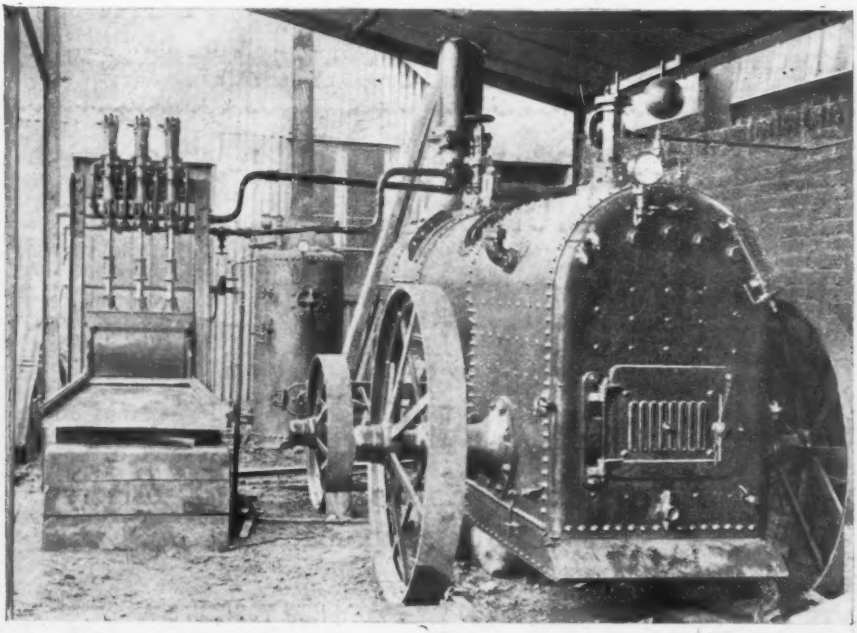
VOL. VI. NEW YORK, NOVEMBER, 1901. No. 9.



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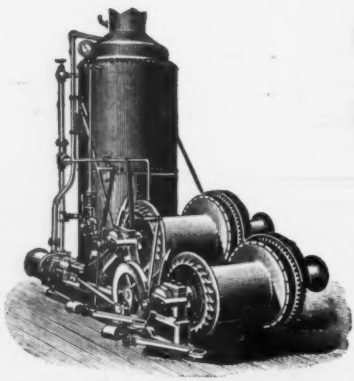

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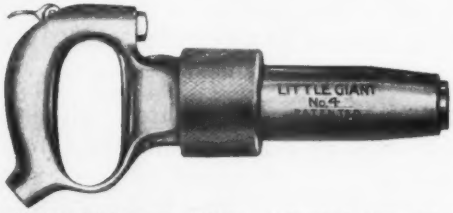

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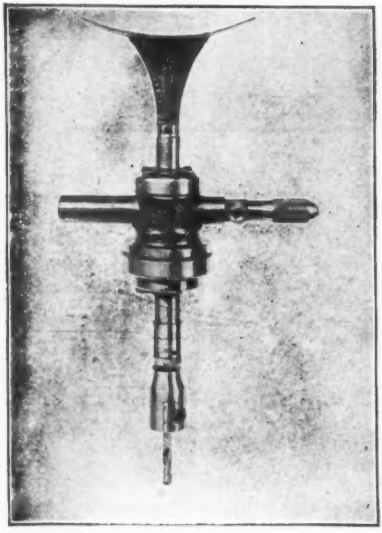

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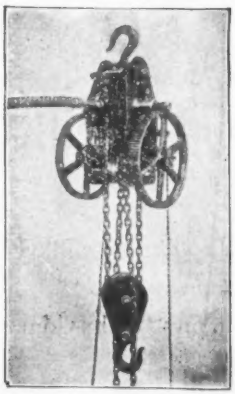

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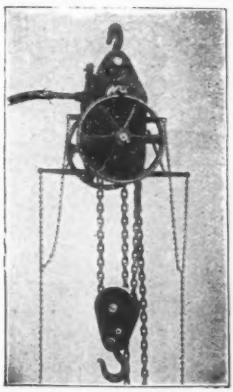

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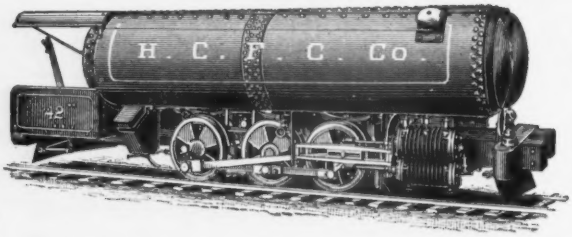

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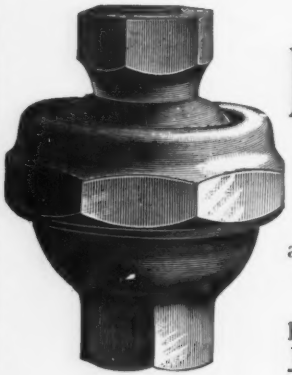

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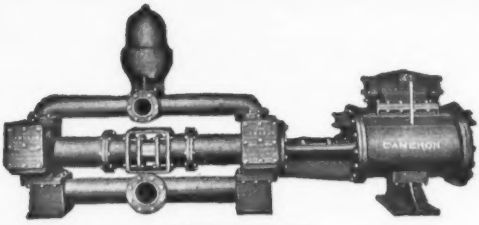

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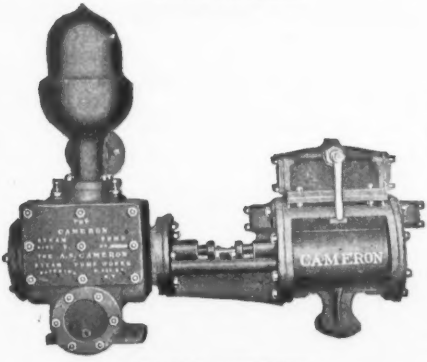

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VOL. VI. NOVEMBER, 1901. NO. 9.

We have so often heard the remark or seen in print the statement that the steam engine has reached its point of maximum development, its prime of life, so to speak, that we are almost indifferent to the oft-told story. That the present form of reciprocating steam engine is an inefficient means of energy, conversion is admitted, but nothing better seems to be at hand and the certainty of action and permanent qualities of the present form of engine, all based on years of experience, make it an old and tried friend.

At the same time, this experience has developed many defects or shown wherein improvements are needed. Why is it necessary to build such ponderous foundations, why must our engine frames be so massive, and other similar questions, often occur to the minds of the purchaser of steam engines. At present, they answer themselves, but these questions arouse the hope that the future has in store some engine which will finally answer all these questions and others, as well as the great one of economy, by a more direct and complete conversion of the potential energy of fuel into a useful working energy. But crowded shops working overtime on the much maligned reciprocating engine do not seem to forbode any cause for immediate worry or change of plans which may include a steam engine.

On the other hand, it is generally admitted that very little room remains for improvement in the engine which employs a cylinder, piston, piston rod and crank, for these have been tried in every conceivable combination. The solution seems to call for something different, something radical, departing completely from the engine which originating with Newcomen, has been added to and subtracted from only to return to the same engine, with a pushing and pulling piston.

Looking back to the time when all that was known of science of any sort clustered about the little world which hardly reached beyond the three countries, Egypt, Italy and Greece, now known more for their historic interest than for anything else, it is interesting to note that two applications of steam were brought to light. One of these, depending upon the expansive force of steam, may be said to be the origin of the steam engine which hundreds of years later under the genius of Watt and Newcomen, was developed into practically the same engine we are using to-day. The other, which might be likened unto a windmill using steam to blow against the vanes, contained the germ of another type of engine which to-day has come to life and is receiving the attention of many, and by some is regarded as the engine of the future. If

this should be true, it but proves the truth of the contention that engineering is prone to fads as well as the fashions.

It is interesting to consider what would have happened had the genius of the early engineers turned towards Bianca's steam turbine instead of Hero's engine. Would it have made the world's history different, and a hundred other like questions come to mind.

The fact that Newcomen and others discarded the turbine in favor of the piston type cannot be taken as any proof of the superiority of the piston type, for the summation of all knowledge on the subject at that time would not equal a school boy's knowledge of such subjects nowadays. Or such an argument would be entirely refuted by the fact that to-day after over a hundred years' experimenting with the reciprocating form, involving the construction of millions of horse power of this type, many engineers are drifting into the belief that the engine of the future will be of some rotary form.

Indeed, substantial evidence to this prediction is afforded by the fact that already two large engine manufacturing concerns have been for a long time experimenting with steam turbines and are now regularly manufacturing and selling this form of engine for commercial use.

Two types are represented; the De Laval, described elsewnere in this issue, a form depending on Bianca's principle and using a disc with small paddles on its circumference against which jets of steam impinge, and the multiple expansion form or Parsons' turbine, both named after the inventors of the respective types.

In the De Laval form the cardinal principle is the entire expansion of the steam in the nozzle from which it issues at exhaust pressure. The available energy is that contained in the particles of steam moving at a high velocity, much as if a jet of sand or water were issuing from the nozzle, instead of steam. This is accomplished by enlarging the nozzles according to certain laws which may be represented mathematically. For best action under these conditions, the periferial velocity of the buckets must be equal to one-half the velocity of the fluid constituting the jet.

In the case of high pressure steam discharging into a vacuum, it is calculated that this velocity is from 3,000 to 5,000 feet per second, and this, as will be seen, means enormously high velocities for the rotary member of the engine.

High speed of rotation introduces a serious difficulty in that it is very difficult to balance the rotating medium which results in uncomfortable and dangerous vibrations.

In the De Laval turbine as constructed at present, this difficulty is overcome by means of a very slender shaft on which is mounted the impact or paddle disc. No matter how carefully this disc is balanced beforehand, when it is brought to the high speed necessary, it assumes a different rotation position. The elasticity of the small shaft permits of this change to be made without transferring the vibration to the frame of the engine. The enormously high speed of the revolving disc is translated into a practical speed by means of gears running in oil.

In the smaller sizes of machines using this principle, speeds as high as 30,000 revolutions are obtained, and in the larger sizes as much as 10,000 revolutions per minute.

Tests of these machines show steam consumptions ranging all the way from 14 pounds to 50 pounds per brake H. P.

In the case of the Parsons' turbine an entirely difficult principle is followed. In this the impact blades are mounted on a stepped drum in series, there being several rows on the large step of the drum, several other rows mounted on the next smaller size, and a greater number mounted on

the third or fourth step, as the case may be.

The casing in which this stepped drum revolves on its inner face has a corresponding set of inwardly projecting blades so spaced as to fit in between the blades of the revolving drum. These blades are curved and may be compared to the paddles on a water turbine, although very much smaller. The opposite end of the revolving drum has discs corresponding in size to the portions which are given up to the blades.

The shaft has suitable thrust bearings to prevent any play of the drum, and as a further precaution to avoid strain on the bearings, steam is admitted to the back of the discs in such a way that the pressure is completely balanced and the drum free to turn without any end thrust. High pressure steam is admitted to that end of the casing surrounding the small portion of the drum and darts back and forth between the casing paddle and the drum paddle, and by its reaction while expanding imparts to the drum an impulse. These impulses are occurring throughout the entire circumference of the drum and result in a powerful rotative effect. The steam, now partially expanded, passes into the next larger chamber, expands a second time in passing between the blades, arrives at the third drum and expands for the last time to practically atmospheric pressure. On account of this expansive use of the steam in the machine itself, and further on account of the smaller diameter of the drum, it is possible to obtain speed sufficiently low to directly connect the engine to generators or any other device.

In the case of a 300 k.w. machine, there is a total of about 31,000 blades, of which 16,000 are mounted in a moving part, and it is estimated that the pressure each blade exerts on the revolving shaft varies from .89 to 1.04 ounces.

An article elsewhere in this issue describes in more detail the De Laval form.

A New Steam or Compressed Air Stamp Mill.*

For the prospector in West Africa the possession of a light and serviceable prospecting mill, capable of easy transport for long distances, is a matter of prime importance. The difficulty of procuring anything of the kind has hitherto retarded very seriously the development of new goldfields, for the expense of moving about an ordinary prospecting mill in a country like West Africa is practically prohibitive.

The stamp mill shown on our cover, it is stated, will deal with 4 tons of quartz per twenty-four hours. A three-head machine with foundation weighs only 13 cwt. (or a complete plant, including boiler and accessories, copper plates, water service tank, water raiser and connections, weighs about 50 cwt., without road carriage). Both the stamp battery and the boiler are portable, as they are socketed on separate road wheel carriages, and the plant can be erected ready for work or dismounted for transit in a few hours. The battery and carriage cost $1,250. Some of the features in this mill are:

The large output of ore treated as compared with the weight of the mill. The high speed of the stamps (250 blows per minute). It dispenses with a steam engine or other mechanical motors to drive, only a boiler being required. Compressed air will serve equally well. High efficiency as shown by reports obtained, as much as 90 per cent. of the gold saved being due to the mill alone. Low cost for maintenance and repairs, the upkeep of shoes and dies amounting to only one penny per ton, due to positive rotation of the stamps. There is less vibration than with gravitation mill, and consequently heavy foundations are not required; in fact, the mill can be worked on its carriage by placing timber, packing pieces under box and taking bearing on the ground. Old mills can be readily and cheaply converted, as in this machine the ordinary shape of mortar-box is not departed from, and the new portions can be used with mortar-boxes of the recognized type.

Our cover shows the three-head mill in full work, complete with locomotive boiler to drive it. The demonstrations given seem to justify claims made for it. The

* Abstract of a description in "West Africa," August 3, 1901.

mortar-box framing, shoes and dies, tables, water service, etc., are the same as in an ordinary prospecting gravitation plant, but in place of the cam shaft, cam and tippets, there is fitted on the cross frame a series of steam cylinders, the piston rods of which are also the stems to which the shoes are attached in the ordinary way. The device is simplicity itself, and permits of ordinary gravitation mills, whether of the prospecting or heavier fixed type, being readily converted to the new system. One of the chief features about this mill is the provision made for securing absolute and definite rotation of the stem, thereby insuring more even wearing of the shoes and dies than is possible to obtain with the cam action usually employed. A copper fan-plate, silvered and placed in front of the screens, has been effectively employed to increase the amalgamating area of the copper plates. This will deal successfully with six tons of alluvial or four tons of quartz per day of twenty-four hours.

The following analysis of work done by the "A" size prospecting mill at the Coolgardie Exhibition, 1899, shows the efficiency of the plant: Stone crushed, 50 tons; mill ran 295 hours; average, 4·07 tons per 24 hours; smelted gold obtained, 68 oz. 8 cwts. 3 grs.; average grade of ore crushed, 1·68 oz. per ton; average extraction, amalgamation only, 88·5 per cent.; average yield per ton, amalgamation only, 1.36 oz.; frequent assays proved the entire absence of gold in the tailings.

A certificate of sample crushing at the Exhibition, signed by Mr. A. E. Thomas, shows that the percentage of total contents saved from boxes and plates was 88·9 per cent., and from the concentrates 1·1 per cent., the total gold saved by the mill being thus 90 per cent. of contents. There was no free gold whatever in the tailings.

It may be stated that the average output of a three-head prospecting mill of the ordinary gravitation type is about 2 to 2½ tons per twenty-four hours, and the weight of such a mill, with driving power, in the form of engine and boiler, etc., is not less than 5 to 6 tons. The steam battery here described doubles the output, say 4 tons. This great reduction in weight and increase in output is due to the greater number of blows given per minute, 250 as compared with 90 in the gravitation mills, and also to the fact that the filling weight in the steam battery is only 14 lbs. per stem as compared with 400 lb. in the gravitation mill, the velocity and pressure of the steam more than compensating for the dead weight. The battery can be seen working in London on application to Messrs. Hathorn & Co., of 10 New Broad street, E. C., to whom we are indebted for the illustration on our cover, who are now placing it upon the market. Its superiority over any others now offered for use in West Africa will be at once manifest to those having any knowledge of the difficulties of transport to be overcome in that country, more especially as it can be made with one stamp only, exactly one-third the present size, and in sections suitable for transport up country.

The Steam Turbine.

The problem of thermodynamic energy conversion so far as the reciprocating steam engine is concerned is to-day only little nearer its solution than it was more than a century ago. Revolutionary in its applications and achievements, the steam engine, originating with Newcomen and perfected by Watt, is, however, very far from perfect as a heat engine, and there seems little prospect that future improvements will bring this type of heat motor any closer to the ideal. This assumption is to some degree borne out by the fact that the improvements ever since the days of James Watt have been in mechanical detail, and even though these have increased its efficiency, the steam engine of to-day presents thermodynamically practically little improvement over that of Watt.

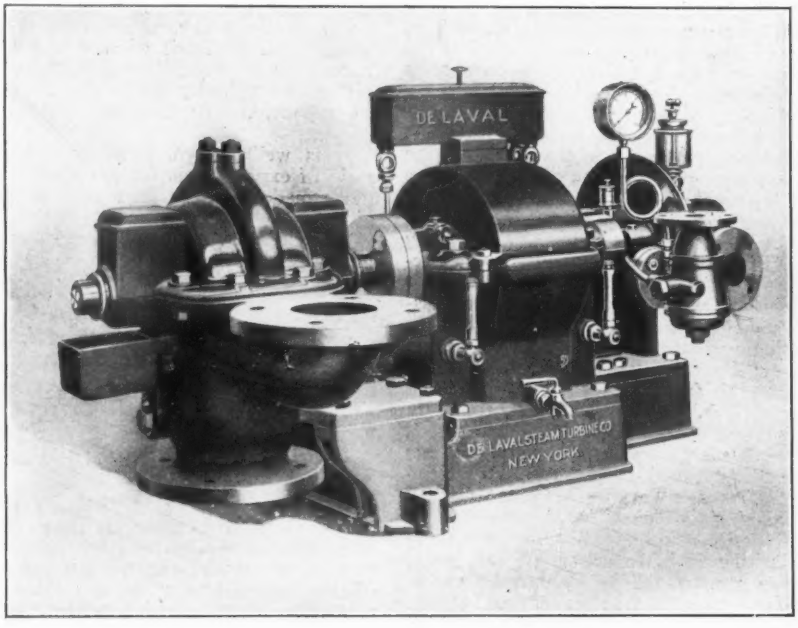
The conversion of heat energy by means of the steam engine is accomplished by allowing steam to expand behind the piston, not utilizing its kinetic energy, but subjecting it to a resistance corresponding with its pressure. The ideal efficiency of this process, and in fact the solution of the problem of thermodynamic conversion, is expressed by the Carnot Cycle represented in the formula:

$$\frac{T - T_1}{T}$$

This means that for the highest efficiency obtainable the steam should be expanded from maximum to minimum pressure and temperature, and furthermore this expansion should be adiabatic, which, as is well known in practical operation with the steam engine, is not and never can be accomplished.

Since the discovery of the latent power of steam and more particularly since the limitations of the reciprocating engine have been defined, inventors and engineers have endeavored to devise means for the mechanical utilization of heat energy by methods promising a closer approach to the ideal than is possible with the reciprocating engine.

Activity along this line of research has been most marked in the past century, and among the devices having any pretence to rivalry with the reciprocating



15 H. P. STEAM TURBINE PUMP.

form has been the rotary steam engine. This type of engine, successful in obviating the defects due to reciprocating motion has, however, in other respects proven so far inferior to the type it was designed to replace, due to large consumption of steam.

Many claim that the solution of the problem cannot be found here, and in fact cannot be found in a mere mechanical differentiation. Research pursued in other directions has developed the steam turbine as proposed by De Laval.

The steam turbine in principle and even in type is not new, being in fact the first heat motor recorded in the history of steam engineering, as far back as 120 B. C., when Hero of Alexandria describes an apparatus for utilizing heat energy. This apparatus, a reaction turbine, consisted of a spherical vessel mounted upon trunnions through which steam was admitted to finally issue from nozzles tangenial to the sphere. Many centuries later, in 1629, the Italian, Giovanni Bianca, brought out the impact turbine, employing a jet of steam to impinge upon vanes or blades of a wheel. This latter, familiar to us in the hydraulic motors of the Pelton type, exhibits in general principle the characteristic features embodied in the present day De Laval steam turbine.

Thus we see as early as 1629 the introduction of the reaction and impact turbine, although of imperfect form and not capable of practical application, and all attempts along these lines have, until within a comparatively short time, proven suc-

cessful. It has been claimed by some that the interest aroused by the success of Newcomen in 1705, and later by Watt and his followers, in perfecting the reciprocating engine, was responsible for the neglect of the turbine engine.

The steam turbine in the form produced by De Laval is characterized by great simplicity of construction and the directness of its energy conversion, producing adiabatic and complete expansion, ideal conditions which can never be attained with the steam engine. That the steam turbine, which now begins to appear as a rival to the steam engine, should have been known at such an early date and yet should have been so long delayed in its reduction to a practical form, may seem astonishing. This is, however, not remarkable, for even if, as is improbable, the high efficiency of the steam turbine had been known to Hero, Branca, and others of early times, a practical steam turbine could not well have been produced for want of materials and tools of such refinement and quality as we to-day know are essential to the construction of a successful steam turbine.

In 1883 De Laval made the first successful steam turbine, using it in direct connection with the shaft of the well-known cream separator manufactured in this country by the De Laval Separator Company. This, his first steam turbine, in design and construction a reaction wheel, was, however, soon replaced by one of the Branca type, and of the results attained Prof. Thurston says, "The result was an astonishing efficiency in many cases of good design; and the Branca form, particularly, exhibited such satisfactory qualities as constructed by De Laval for this use as to make it a permanent and standard addition to our list of prime movers."

By use of the diverging nozzle nearly a complete and adiabatic expansion of the steam was secured with a conversion of nearly the entire static energy into kinetic, to overcome the impossibility of producing a wheel accurately enough balanced to revolve about its centre of gravity at a rim velocity sometimes as high as 1,350 ft. per second, without causing a side pressure destructive to plain bearings and a rigid shaft, a flexible shaft was adopted.

The De Laval nozzle and the flexible shaft may well be regarded as the key to the success of the De Laval turbine.

In a properly constructed nozzle, a volume of steam at maximum pressure entering at H. (Fig. 1), gradually, and—as every element of the nozzle assumes a temperature constant and equal to that of the passing steam—adiabatically expands to minimum pressure, and as this pressure is that of the surrounding medium, the steam at the point of discharge (B) issues in a solid jet without tendency of its particles to divert in any direction.

Through numerous experiments Prof. Zenner has shown that theoretically the work of this adiabatic expansion converts the entire static energy of the steam into kinetic, and that the stored energy of a jet of steam issuing from a De Laval nozzle is identical to the amount of work produced if an equal volume of steam is allowed to adiabatically expand behind the piston of a cylinder and at the same ratio of expansion—the diagram ending in a point.

It is well known, however, that such ratio of expansion is for practical reasons never made use of in the reciprocating engine.

The energy (E) of a jet of steam per unit weight is:

$$E. = \frac{V^2}{2g}$$

Where V is the velocity of the effluent steam, and assuming this velocity to be 4,000 ft. per second, which is nothing unusual, we have:

$$E. = \frac{4{,}000^2}{2g} = 248{,}500 \ ft.\text{-}lbs.$$

The velocity of efflux given, and with the nozzle at an angle of 20° to the plane of motion of the buckets, the velocity of the turbine wheel for the maximum of efficiency should be 47 per cent. the velocity of the steam. The absolute velocity of the steam leaving the buckets is then 34 per cent. of the initial, and we find the energy absorbed by the turbine wheel to be 88 per cent. of that expanded.

With V=4,000 ft. per second, we have the horse-power per hour, per lbs. of steam.

$$H.P. = \frac{V^2 - V_3^2}{2g.550.3600} = 0.11$$

And the steam consumption per theoretical horse-power per hour.

$$\frac{2g.550.36000}{V^2 - V_3^2} = 9.1 \ lbs.$$

The speed of the wheel which for

V=4,000 ft. and for the maximum of efficiency should be about 1,880 ft. per second, or about 21 miles per minute, is, however, much lower, as it has been found difficult to produce a material for the wheels that with ample margin of safety would withstand the strains produced by the centrifugal force at this high speed. At the present time the speed does not actually exceed 1,350 ft. per second, which in above case would give a steam consumption of 9.8 lbs. per theorectic horse-power.

At an initial pressure of 150 lbs. per square inch absolute, the energy of a jet issuing at a terminal pressure of 14.7 lbs. absolute is 130,000 ft.-lbs., a terminal pressure of 2.97 lbs. it reaches 210,000 ft.-lbs., and if issuing at 1.47 lbs. absolute, equal to 27 in. vacuum, the energy is 240,000 ft.-lbs.

A high steam pressure and a good vacuum when operating the steam turbine are fully as important as in the case of a reciprocating engine. Not that the steam turbine cannot, as far as the mechanical results are concerned, be operated equally well with low pressures and non-condensing, and even then successfully compete with the reciprocating engine, but whenever the best economy in operating is sought for, high pressures and a condenser should be used, and as the difference and gain in economy in the case of the steam turbine is more marked than in the reciprocating engine it will be found in many cases, and this even for comparatively small sizes, of advantage to operate condensing even in places where the scarcity of water would render the employment of a cooling tower necessary.

A characteristic feature of the De Laval steam turbine is that none of its running parts are subject to the full pressure of the steam, as the steam is fully expanded in the nozzles before it reaches the turbine wheel. This feature, which will not be found in any other heat motor, is of great value and promise in the direction of using high pressures with resultant increase in economy of fuel. The steam pressure that can be used is limited only by the boiler, and turbines have been operated successfully with a pressure as high as 3,000 lbs. per square inch.

Further and considerable increase in economy can be attained by using superheated steam, for which the steam turbine is particularly well adapted, as there are no rubbing parts requiring lubrication, nor packing glands in contact with the superheated steam, and as in the case of high pressures the limit exists again with the boiler.

The De Laval Steam Turbine.

The De Laval Steam Turbine is a high speed rotary steam engine, in design and construction adapted for all purposes where the common reciprocating steam engine is now used. This is especially the case where great efficiency, uniformity of rotation, and close regulation are important, as when used in connection with electrical machinery, centrifugal pumps, fans, blowers, etc. Its high speed and the directness of its energy conversion decreases the dimensions and weight, and simplifies the construction without impairing its efficiency.

Unlike the reciprocating engine and other turbines, this form has no stuffing boxes, no glands, no packing joints, and no working parts under pressure, which entirely eliminates the question of loss from leakage. The efficiency of a steam engine as given in a shop test is apt to be higher than that obtained in practice, while the turbine throughout its entire life remains constant in this respect, and a test made in the shops at the time a turbine is shipped would hold good for the same engine after a number of years of operation.

There is practically no friction loss to contend with in the turbine itself, while in the reciprocating engine the loss caused by poor or improperly adjusted packing and piston or valve rods worn out of parallel is often considerable, and a surprising difference in efficiency is often shown in a number of tests.

It is claimed that when running condensing this turbine will give a better efficiency than a compound condensing Corliss engine. The efficiency of the reciprocating engine is given for its full rated load and the steam consumption per horse-power largely increases with every increase or decrease of the load, while with the turbine the efficiency is practically the same from 25 per cent. load to a 20 per cent. overload. It is undoubtedly a fact that in nearly every case a steam engine is run under-loaded rather than over-loaded most of the time. In other words, the total amount of fuel required to operate a reciprocating engine at half-load is almost equal to the quantity required for a full-load, while with the tur-

bine the steam consumption is nearly proportionate to the amount of work being performed. Fuel cost is beginning to assume an important aspect in this country, and this, coupled with the close competition in most lines of manufacture, necessitates taking advantage of every known means of fuel-saving. The excessive cost of fuel in Europe is often given as the reason of the adoption of the steam turbine for many classes of power work.

As steam under pressure does not come in contact with any moving parts a very high pressure can be used with a considerable increase of economy. This feature is also of great importance when using superheated steam as it removes the difficulties of lubrication at high temperatures. It is undoubtedly with superheated steam that the greatest future improvement can be looked for in the reciprocating engine, but a limit is soon reached on account of the great difficulty of lubrication.

The speed regulation is unexcelled, the high speed, the simple and direct connection of the governing mechanism, and the exceedingly sensitive governor insuring perfect, and under all conditions, safe control of the speed of the turbine, at the same time keeping the variation within very small limits. The value of this cannot be over-estimated, especially where a machine is used for driving electrical ap-

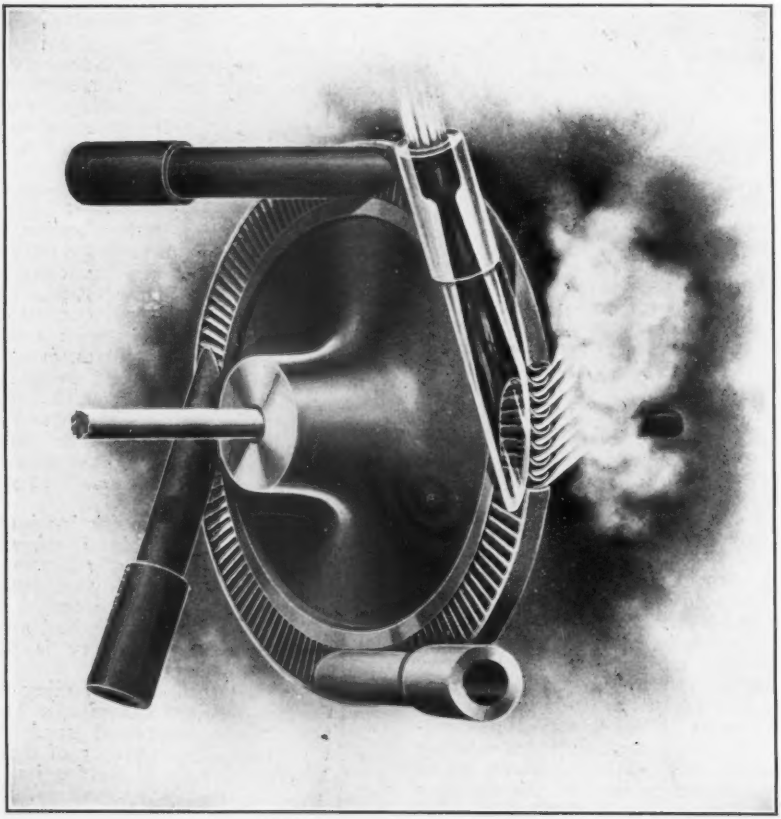


FIG. I.—DE LAVAL WHEEL AND NOZZLE.

paratus, where the full load is often thrown off or on at once.

The entire absence of reciprocating motion and the light weight and perfect balance of all revolving parts removes the necessity of foundations, except such as are required to sustain the weight of the larger sized machines, and as this is much less than the weight of reciprocating engines of the same capacity, the saving in cost of foundations is an important item. In the smaller sizes no foundations whatever are necessary, and turbine of any size may be placed in the upper stories of high buildings without any preparation other than strength enough to sustain the dead load.

that the wear in every case is very much less than in reciprocating engines.

The De Laval Steam Turbine is particularly well adapted for direct connection to dynamos, centrifugal pumps, blowers, fire engines, etc., and some of these combined outfits are shown in the accompanying illustrations, which is a decided advantage over the old method of buying an engine from one place, a generator or a pump from another, and having them fitted together on the ground where used, oftentimes with great expense and delay, and probably a poor piece of work as the result.

High speed, while objectionable in some classes of machinery, is not such a serious

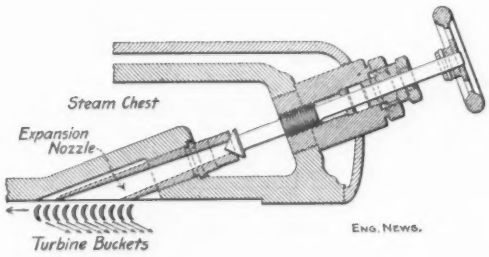


FIG. 2.—DE LAVAL NOZZLE.

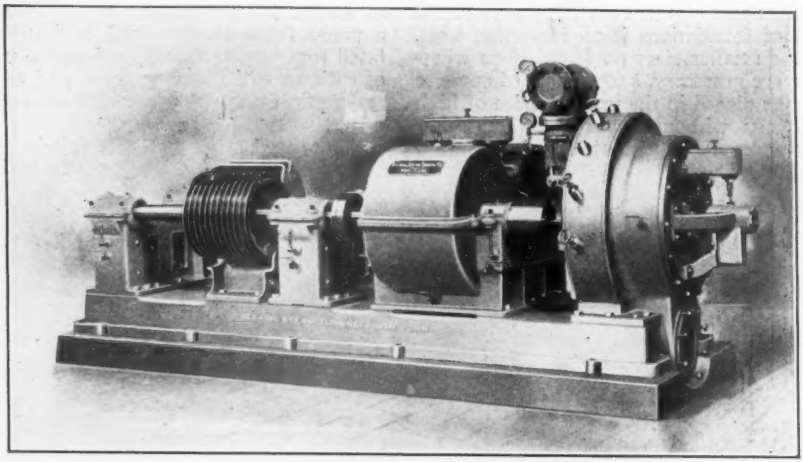
As compared with a steam engine of equal power the space occupied and the weight of the turbine is extremely small. A large part of the metal in a reciprocating engine is used to absorb the shock, which is entirely absent in the turbine, but a sufficient quantity of metal is used in the turbine wherever necessary to withstand any strains it may be called upon to resist, and a large factor of safety is allowed. The saving in space occupied, in cost of building, in transportation and in erection, as well as weight and cost of repairs when needed, are items well worth considering.

Experience extending over a period of about eight years, with upwards of four thousand steam turbines, seems to show

matter in the turbine; the parts being so small, so perfectly balanced, and so well lubricated, are more durable than those of even a slow-moving reciprocating engine. While the speeds used in the De Laval Steam Turbine may seem excessive when applied to a steam engine, they are common practice in other lines of work where the conditions imposed on them are more severe than with the turbine.

The De Laval Separator Company has during the last twenty years placed on the market over two hundred and fifty thousand centrifugal cream separators, which are running at speeds once considered absolutely out of the question, and the fact that these have been placed in operation on farms and in creameries where they

are handled by the most inexperienced class of help, and oftentimes with practically no attention and almost no repairs. In addition to these many thousands of other makes have been sold and are in operation every day at speeds varying from six thousand to twenty-five thousand revolutions per minute. For the illustrations and data used in this article, we are indebted to the De Laval Steam Turbine Co.



DE LAVAL STEAM TURBINE, 300 H. P.

Efficiency of Rock Drills.

The question of efficiency of rock drills is one which is frequently raised, especially by the advocates of new electric or hand-power drills when they are attempting to decry the merits of the steam or compressed air form.

It is quite possible to confuse a man who is well versed in the practical workings of machinery by a discussion of this efficiency question, especially when only one side is used, and it is therefore not surprising that there is an impression current that air drills are not efficient.

In any and every case the question of efficiency depends on a number of conditions, which may be termed local in character. The desideratum, first, last and always, is to get the greatest amount of work in the shortest time with the greatest certainty and the least amount of repairs and the smallest first cost and smallest cost of operation, and in discussing the matter of efficiency every one of these factors must be given its full weight.

In the case of an electrical machine it is fairly easy to determine the amount of energy which is being expended for the moment because it is only necessary to insert an ammeter and a voltmeter in a circuit and take simultaneous readings.

This is all right as far as it goes, but it only goes a little way toward the final determination of the efficiency of a mining or quarrying equipment. Unfortunately these are the only questions which are as a rule considered when the efficiency of an electric drill is brought up for examination. In reality they are least important, for the practical questions of repairs, durability, readiness for work, lightness, simplicity, ease of operation, safety and amount of work in actual feet of hole drilled, are the weighty factors, because these determine whether you will make or lose money in the long run.

We know of a case which is rather in-

teresting attempt to test the power of a drill by hammering on a steel plate for a short time and afterwards subjecting the same plate to a steady hydraulic pressure until the plate was reduced to the same thickness as that resulting from the hammering. A little figuring formed the next step and a result was obtained calculated to convince the most skeptical. However, this is no argument as a powerful blow alone does not make a successful rock drill.

Mining and Scientific Press in discussing this efficiency question editorially sums up the matter in a very concise manner and we cannot do better than to quote from it direct:

"Experience shows that a successful rock drill must fulfill a number of requisites, among which the mechanical efficiency is not by any means the most important. The methods which would naturally suggest themselves to improve this efficiency would, at the same time, make the machine impractical, and the best that can be done in this direction is apparently to eliminate all hindrances to the delivery of the blow from the piston to the rock, i. e., to avoid cushioning on the fore end of the piston—and to maintain the full pressure of air on its back end as long as practicable. Quick action is also a desirable feature and means wide and short passages between the valve chest and the cylinder at a possible increase in the air consumption of the machine.

"But while these requirements may be said to always exist, they must be satisfied to various degrees, according to the nature of the ground. The true value of a rock drill is ultimately gauged by its capacity for making a rapid advance in a given sort of ground and this involved not only the percussive power of the machine, but also its adaptation to "mudding," i. e., to keeping the hole free from obstructions.

"The result is that an efficient machine, i e., one designed to deliver a powerful blow on hard rock, may not do comparatively as good work in soft or seamy ground, while a test of its percussive capacity would have led to declare it efficient.

"The pull and the twisting moment can be estimated from the air pressure, the size of the piston and the pitch of the rifle bar, but the result of this computation may be of little use in determining the actual working value of a rock drill."

Theoretical tests no matter how ingenious are not final and do not give information which you as a practical man in need of a simple, durable, cheap and powerful drill, are after. The test of time and the admiration of the majority of practical mine and quarry owners and operators are the points which prove the efficiency of the rock drill.

Pneumatic Tools in Building.

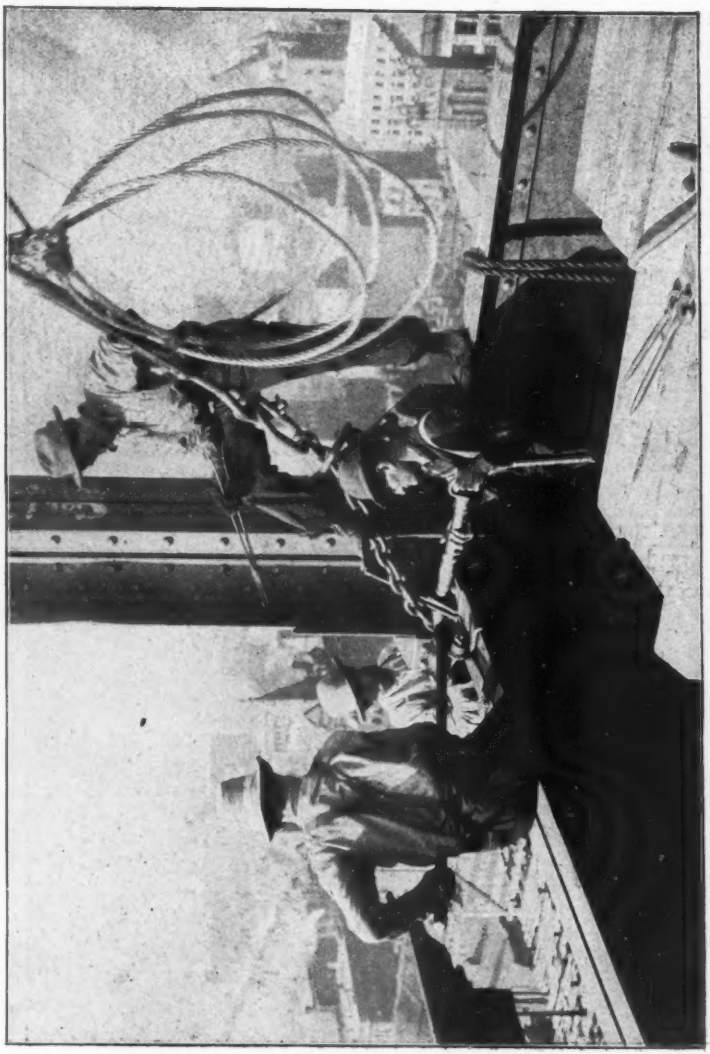
The use of pneumatic tools in building and bridge construction is no longer a novelty and the use of those labor savers has become almost common practice. The accompanying pictures are not therefore presented with any idea of novelty. They are, however, excellent illustrations of the utility of pneumatic tools to structural work, and we are confident that on this account they will be of interest to our readers.

Figs. 1 and 2 are views taken in the construction of the Frick Building, Pittsburg, Pa., and show the use of the No. 9 Boyer Long Stroke Hammer and the pneumatic Holders-on.

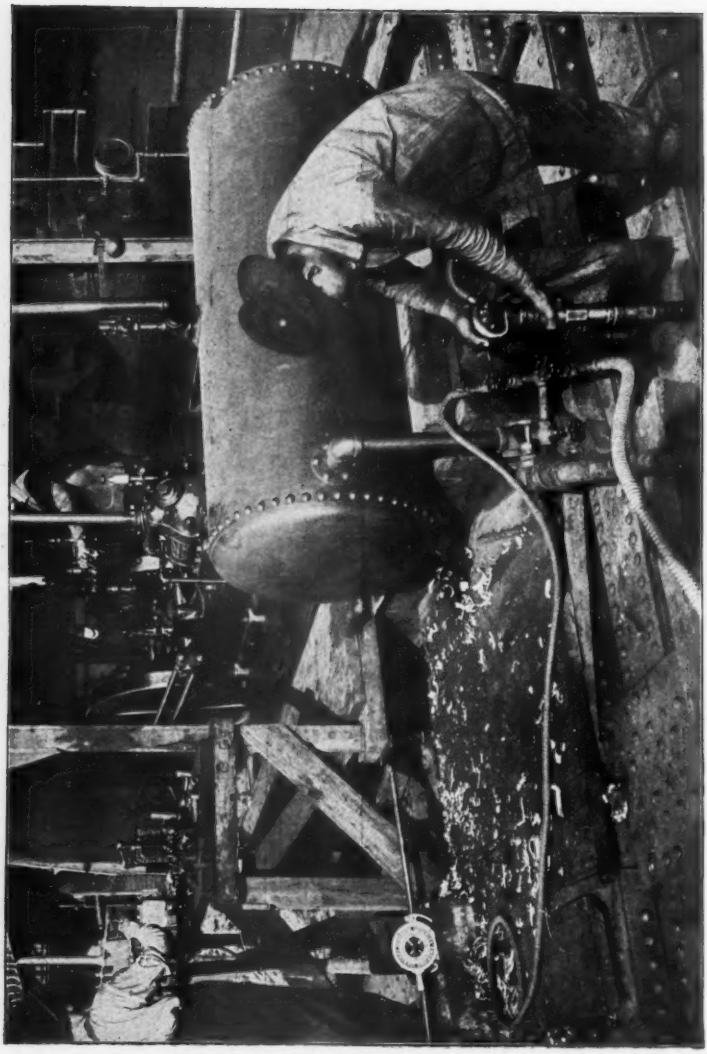
Fig. 3 represents a small compressed air plant, suitable for the production of compressed air for operating tools in the case of structural work, and is the compressed air equipment in use on the viaduct work at the Union Depot, Pittsburg, Pa. A small compressor is seen in the background, while the tank is a receiver used to collect the air and avoid pulsation in the air main which is run to various points where the tools are to be operated.

For the illustrations and the accompanying description we are indebted to the Chicago Pneumatic Tool Co., Chicago, Ill.

VIEW SHOWING NO. 9 LONG STROKE HAMMERS AND BOYER PNEUMATIC HOLDERS-ON IN USE ON FRICK BUILDING, PITTSBURG, PA.



VIEW SHOWING BOYER NO. 9 LONG STROKE HAMMER IN USE ON FRICK BUILDING, PITTSBURG, PA.



VIEW SHOWING NO. 9 BOYER LONG STROKE HAMMERS AND NEW YORK FRANKLIN AIR COMPRESSOR EQUIPMENT IN USE ON THE VIADUCT WORK AT UNION DEPOT, PITTSBURG, PA.

Economy Through Reheating.

Coal machines take very little air individually and as they are constantly being moved from place to place, there is but little in reheating. Generally speaking, nothing is gained for purely intermittent work. For this reason the best practical results for coal cutters lie in tight pipe lines and economical machines well kept up by runners with good judgment. In many mines, as much air is used for pumps as for the cutters, and sometimes a great deal more in stationary haulage engines located underground, and many an overworked compressor would be ample for the duty if the air was expanded by moderate reheating previous to its use, Compound pumps, for instance, will give trouble from freezing, if the air is not heated before being used in the first cylinders and is then exhausted into a heater through which it passes on its way to the low pressure cylinders. With this great economy may be effected. In some cases from one-quarter to one-third the amount of air originally consumed in pumping can be made to do the same work, thus leaving at once a large volume of air for other service, or in the case of a new installation, reducing the size and cost of pipe, compressors, boilers, etc.

MINE WATER TO HEAT.

A method for interheating the air used between the cylinders of a compound pump, consists in the insertion of an ordinary feed water heater into the suction or discharge line through which the water is pumped, the cold exhaust air passing through this heater on its way to the low pressure cylinders, much after the manner of boiler feed water. The mine water is not hot, of course, but all things are relative. Exhaust air is often many degrees below zero, and as compared with that temperature, mine water at 60 degrees is quite effective as a means of heating; under this system there is no freezing, and the air consumption is cut in two. This may be carried into triple or quadruple expansion for large plants of heavy duty. A hoisting engine can be arranged for reheating very readily, but in all cases the heater must be placed as close as possible to the cylinders using the air. The heater should be carefully covered with magnesia and all hot pipe connections and cylinders using the air fully protected. The usual reheating temperature does not exceed 350 degrees, a temperature that gives no trouble with lubrication, stuffing boxes, etc. The usual rule is not to heat to a point higher than will result in the exhaust being at mine temperature, thus in no way interfering with comfort or ventilation. The exhaust of a rock drill on a hot summer day was found to be far below zero, though the air was used full stroke and without expansion, but when the air was heated to a point which resulted in an exhaust temperature about equal to the atmosphere, it was found that very nearly 100 per cent. efficiency was secured. It is surprising what a small amount of heat is required, the results often being six to ten times more important than results from the same amount of fuel burned in a boiler furnace.

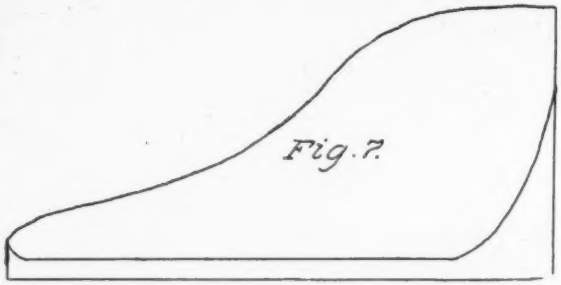
USING STEAM.

As a general thing, however, steam offers the best means for heating in a coal mine, since there are usually objections to fire underground. A very small pipe, say ¾″ up to 2″, carefully covered with magnesia, will carry an enormous amount of heat in the form of hot water or low pressure steam, and distances up to two miles are entirely practicable. This is different from piping steam to a pump, for instance, because it is heat more than power or pressure that is wanted, and if it only arrives as hot water, being fully protected on its way, it neither results in discomfort or a loss in power of importance.

One heat unit will raise one pound of pure water from 39.4 degrees to 40.0 degrees, that is, make it one degree warmer, while the same amount of heat will raise one pound of 13 cu. ft. of air four degrees. In other words, the specific heat of air is about one-fourth that of water, hence, air is readily heated; there is no question of freezing where air is heated. Thus, three important points are secured, absence of freezing, reduced cost of plant throughout and a great increase in permanent economy.

Indicator Problems—II.

With a positive motion cut-off, as shown in Fig. 7, we have somewhat different results. The action of the governor (it being a shaft or wheel variety) immediately controls the movements of the cut-off eccentric, which acts upon the cut-off valve and gradually closes the opening until the point of cut-off is reached. While the result is sure in making a positive cut-off at each stroke at any point which the governor shall determine up to the end of the stroke, yet the steam line will show a slightly diminished pressure from the initial to the point of cut-off, which point is rather difficult to exactly determine, as seen in the cut.



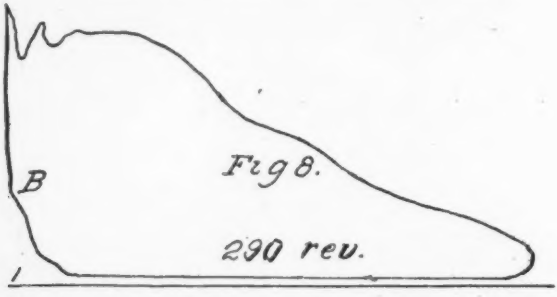
The expansion line is quite as good as in any other form of cut-off.

In the drop motion cut-off, in case by accident the valve rod should not hook on or become detached at the proper time, the steam would not enter or cut-off, as the case may be, and thus irregular speed would result, which might lead to accident, and probably serious result might follow.

Referring again to the cut, Fig. 7, we find the steam line very smooth and gradual in reduction of pressure from the point of initial to terminal pressure, but more abrupt after cut-off has taken place.

In regard to the exhaust valves, the effect is most excellent; the exhaust line is very regular and even pressure until the exhaust valve closed, when compression began at four-fifths of the stroke.

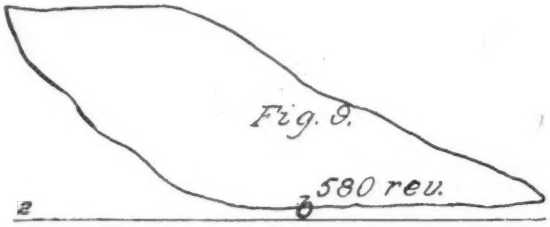
The compression line gradually meets the admission line, thus saving much direct steam. The engine passed the centers very smoothly, without jar or pound, although running at high speed. This card may be considered as a fair sample of Cummer engine cards.



One of the most noticeable features of an indicator diagram, particularly if taken at a high speed, is found at the commencement of the steam line. Many engineers wrongly attribute this to excessive compression, whereas the momentum of the moving parts of the indicator is the only cause. A typical formation is shown at A, Fig. 8, and can be taken as evidence of a proper action of the instrument and not a feature which it is desirable to eliminate.

Where the moving parts are excessively heavy, vibrations of such magnitude are induced as to seriously affect the accuracy of the card, and it is, therefore, desirable to select, for high-speed work, an indicator having the lightest moving parts consistent with durability, though the writer has noticed that when the engineer's suspenders get on terms of undue familiarity with the pencil arm, be the construction light or otherwise, the results are equally serious; and this or some similar cause is usually responsible for such breakages.

After noticing the effects of momentum as exhibited at A, Fig. 8, at a speed of 290 revolutions, a diagram (Fig. 9) from an engine making 580 revolutions is surprising to those to an extent unfamiliar with the subject.



An examination of Fig. 8 will show that the line A B was made almost instantaneously, while in drawing the same line in Fig. 9, more time was consumed than by the engine in making one-quarter of a revolution, and as momentum equals the weight multiplied by the velocity, it can be readily understood why the card, taken at the higher speed, should show so little of the effects of weight.

Diagram No. 10, at 310 revolutions, was taken from a prospectus issued by the manufacturer of the indicator, and can be almost duplicated in the catalogues of many engine builders; such a card only serves to show that some indicator manufacturers have much to learn about the use of the instrument; at this speed, such a steam line and impossible cut-off would condemn the indicator, provided a readjustment and the liberal use of oil did not work a change in the appearance of the card. When we consider that all the literature on this subject, in the possession of many learners, is embraced by these catalogues, it is but right that they should be written with care and a due regard for truth; also that impossible diagrams, purely the result of a disordered imagination, should not be placed before the unsuspecting public as the ideal result of a perfect indicator.

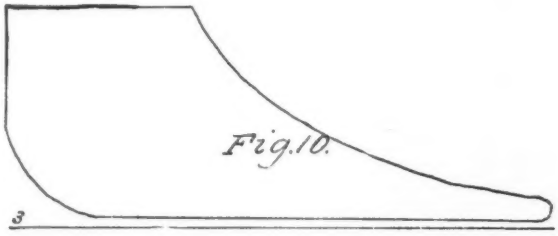


Diagram II was taken from a Corliss engine, and at A and B peculiarities are apparent which were variously attributed to faulty action of the indicator, water in the cylinder and other causes. The explanation is simple. When the piston had barely started on its stroke, and while the volume of steam was small, cut-off took

place; at this point only a small movement of the piston is required to reduce the pressure rapidly, and in their quick descent the moving parts of the indicator acquire sufficient momentum to carry the pencil below the position it should occupy, where it stops, and as the drum is moving, a short horizontal line is the result. Were inertia overcome before the pressure decreased sufficiently to prevent it, a tendency to rebound slightly would be noticed, as shown by dotted lines.

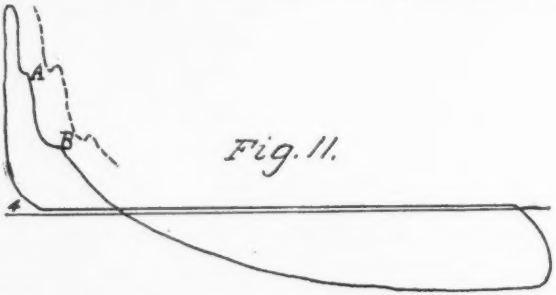


Fig. 11.

At no time is the result of momentum more apparent than at the point of exhaust, and the error is all the more serious because not so easily detected. An examination of Fig. 12 will show two distinct types of exhaust. At A the pencil gradually descends, and having but little momentum does not reach its proper position by an amount equal to the friction of the instrument. At B the pencil drops suddenly to a position lower than it should and unless there existed a difference in pressure greater than the friction of the indication, the back pressure line of this diagram would be about as much below the correct line as the other would be above, were no other causes considered.—*The National Engineer.*

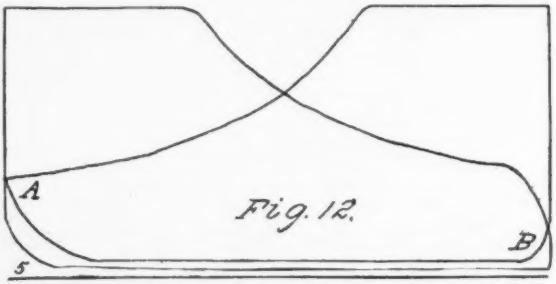


Fig. 12.

Pneumatic Chain Hoists.

This type of air hoist is under perfect control of the operator, and will start, stop and hold its load at any point, as it does not depend upon air pressure to sustain the load. This hoist can be suspended upon a trolley and run in any direction, or upon a boom of jib crane, or in any position where block and fall can be used.

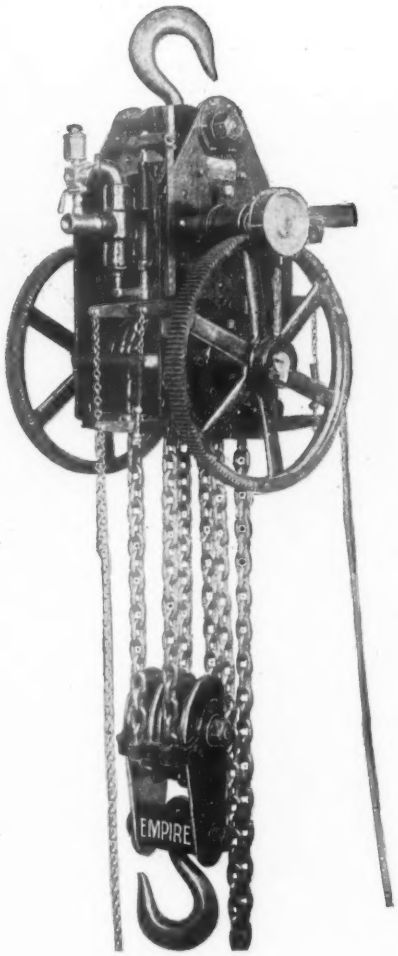
It is a compact, solid and well-balanced hoist, consisting of two side plates, between which is placed the motor, winding drum and all working parts except the pinions and gears, which are outside.

The motor is reversible, with a pinion on each end of the shaft meshing into two large gears placed on the ends of the sprocket drums, over which the chains run.

On this account any length of lift can be obtained, but as furnished the chain is made 25 feet long, which gives a 10 ft. lift.

The Empire Engine and Motor Co., Orangeburg, N. Y., to whom we are indebted for this information and the ac-

companying illustration, further state the sizes and capacities of these hoists as follows:



CLASS A.

Capacity.	Speed Under 80 lbs. Pressure.	Length over all Inside to Inside Hooks.	Weight.
1,500 lbs.	10 to 13 ft. per min.	32 inches.	160 lbs.
3,000 "	" " "	43 "	290 "
5,000 "	" " "	48 "	425 "
10,000 "	" " "	60 "	575 "
	CLASS B.		
800 lbs.	28 to 36 ft. per min.	32 inches.	160 lbs.
1,500 "	" " "	43 "	290 "
2,500 "	" " "	48 "	425 "
	CLASS C.		
1,500 lbs.	15 to 20 ft. per min.	32 inches.	190 lbs.
3,000 "	" " "	43 "	320 "
5,000 "	" " "	48 "	450 "
10,000 "	" " "	60 "	595 "

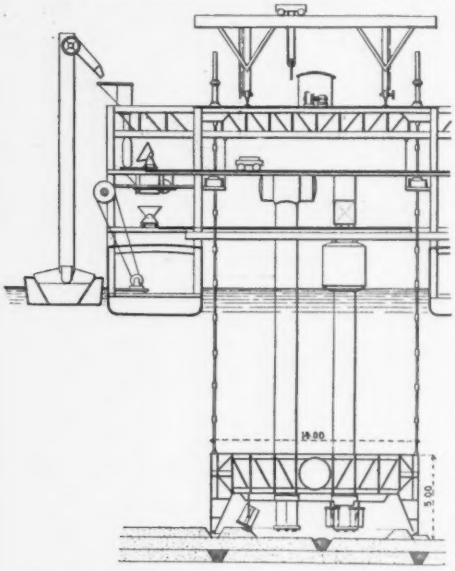
Dry-Dock Foundation at Kiel, Germany, Laid from a Floating Caisson with Compressed Air.

At Kiel, Germany, the foundations for two dry-docks are being laid with a floating caisson, the men working under compressed air. The basin of each dock is 574 ft. long, 98.4 ft. wide, and 37 ft. deep at mean water. The conditions required that a floor of concrete be laid at a depth of 54 ft., and this floor was about 600 ft. long by 135 ft. wide and 14 ft. thick for each dock.

To lay this concrete, a steel caisson was built, 137.75 ft. long, 46 ft. wide and 16.4 ft. high; 8.2 ft. of this height being reserved for a working chamber, and the same height for an equilibrium chamber. The caisson weighs 350 metric tons, and is operated much like a diving bell. It is suspended by 20 chains and screws from a triple truss structure supported by two steel boats, each 170.6 ft. long, 20 ft. wide and 14.76 ft. deep. On the truss is located a rolling crane for handling the material. Two air-shafts, one for men and the other for material, connect the sunken caisson with the bridge above.

The concrete is deposited in layers 1½ to 2.5 ft. thick, and these layers are arranged in such manner that the separate blocks, made by depositing the concrete inside the working chamber, break joints; and the trenches formed in any one layer by the cutting edges of the caisson are filled up in the succeeding layer. The con-

crete is mixed on the caisson and falls into buckets at the bottom of the shaft, which are carried by an over-head traveler to the point of deposit in the caisson. For changing the position of the caisson four hours are required. The heavy walls forming the sides of the dry-dock will be executed in a similar manner to a point about 10 ft. below mean water, and the remainder will be constructed with a different caisson in a similar manner to a dock at Marseilles. The compressed air work was commenced in February, 1900,



FLOATING CAISSON FOR LAYING CONCRETE UNDER WATER WITH COMPRESSED AIR, KIEL, GERMANY.

and will continue for three years for the two dry-docks to be built.

The air-shafts and lock for admitting the men to the working chamber are provided with automatic apparatus regulating the time of passing into and leaving the compressed air. The rule adopted is: Time of entering, 10 minutes per atmosphere; leaving the lock, 20 minutes per atmosphere. The engineers in charge of this work are Mr. K. Sonntag, Chief Engineer of the company, and Mr. A. Hagg, Chief Engineer of the Kiel docks. This description is abstracted from the *Annales des Ponts et Chaussees*, for the first quarter of 1901.—*Engineering News.*

The Philadelphia City Hall Clock.

Tower clocks are usually subjected to the greatest of disadvantages that clocks have to meet. They are generally exposed to all conditions of weather, with variations of temperature that not only vary the length of the pendulum, thus altering the vibration rate, but also affect the lubricants in the mechanism by gumming, etc. Also, the usual large size of their hands makes considerable power necessary to run them, and, owing to changes of wind, and to the snow and sleet, varying powers are required.

In designing the clock for the Philadelphia City Hall tower, an attempt was made to obtain a timepiece that should be accurate in spite of the hindrances previously mentioned and also of those to be met particularly in that tower, due to vibration on account of its great height of 547 feet. In order to accomplish this, the old method of driving the hands on the dials by direct mechanical connection to the clock was abandoned, and provision made whereby the dial mechanism should be actuated by pneumatic connection from a master clock, which might thus be entirely removed from the tower and subjected to the most favorable conditions. In this way it became possible to employ an astronomical clock of the greatest possible accuracy.

The astronomical master clock was placed in the lowest room in the tower, 200 feet below the dials, where the walls of the tower are 13 feet thick, thus insuring complete stability and freedom from jar, and is housed in a small room, or booth, of glass, which was so made as to be as perfectly air and dust-tight as possible. This prevents dust accumulations, so detrimental to delicate mechanisms. The clock is mounted upon a heavy iron pedestal, weighing over 500 pounds, with a glass door for view of the pendulum, and the pedestal is provided with three leveling screws for leveling and adjusting the pendulum's swings at any time. The weights which run the clock have a separate compartment in the pedestal from the pendulum, so that the passing of the weights will not cause air currents and affect the air-friction of the pendulum. The dial mechanism is above the iron base and is enclosed in a glass casing to further provide against dust, the winding up of the weights being accomplished by a long key entered through a hole in

the glass case, which hole is otherwise kept plugged. Thus the clock has double protection against dust, and especially so as the room is not allowed to be entered but once a month for winding the clock. This protection is so effectual that no dust accumulates in the clock room, even in a period of six months. For further uniformity of conditions, a thermostat is provided in the clock room, which, by means of a pneumatic connection, controls an electric heater at one side of the room, so as to maintain the temperature therein constant at 75 degrees F., and it does not vary more than 1 degree throughout Summer and Winter, so it may be seen that this astronomical clock operates under the most perfect conditions of any clock in the world.

The pneumatic device whereby the sets of hands on the four tower dials, each of which sets weighs over 500 pounds, are driven from the delicate astronomical clock, without interfering with its accuracy, is very ingenious. It consists primarily of a small valve that is alternately held open for half a minute and closed for half a minute by a cam on the second hand arbor of the astronomical clock, the cam operating the valve through a magnified leverage, so as to require little power. The action of opening of this little controlling valve is to release the pressure in an equalizing diaphragm, allowing withdrawal of a system of small levers which causes the shutting of a valve leading from the compressed air supply to the cylinder of the minute hand mechanism at the dial, while the closing of the controlling valve causes an inflation of the equalizing diaphragm, forcing out the system of levers and thus opening the supply valve. The dial mechanism, of which there is one separate for each of the four dials on the tower, consists of a cylinder and diaphragm which actuates a large anchor escapement, in which the anchor pallet is driven by the cylinder and, in turn, drives the escapement wheel, contrary to the usual cycle of movements in such escapements in clock movements.

Thus it may be seen that the dial mechanism cylinders receive pressure and release once every minute, which results in the anchor pallet moving back and forth once, thus moving the minute hand over one minute on the dial. As long as the astronomical clock, which moves the controlling valve, continues to run, the hands on the dial will follow its movements with absolute fidelity, and, as the astronomical clock is capable of the most rigid accuracy under such favorable surroundings, the dials are assured of correct time indications.

For accuracy of setting the clock to correct time, as well as keeping it corrected, a telegraphic connection by direct wire with the U. S. Naval Observatory in Washington is furnished in the astronomical clock room, as well as a city telephone for communication with the local observatory. To furnish the compressed air there are provided two electrically driven air compressors in the dial room, as well as a set of three hydraulic air compressors in the basement in the engine room, which stand ready to go to work automatically the instant that anything happens to shut off the electrical compressors. The dials are the largest dials in the world, being 25 feet in diameter. They are illuminated at night, each dial being abundantly provided with 150 incandescent lamps, and the lighting current is turned on in the evening and off in the morning by automatic machinery at the proper times. A new departure was attempted upon the dials by the omission of the usual numerals designating the hours. The usual numerals are replaced by simple heavy black bars, the hands being made very large and prominent, so as to be of more value by position, and at the great height the change is hardly noticeable. Since the completion of the system there have been very few derangements, on account of nearly every part being arranged in duplicate, so that almost no combination of accidents can serve to stop the dials.

For further particulars in reference to this very interesting system, reference may be had to the Journal of the Franklin Institute of February, 1901, from which this account was condensed.—*Machinery.*

Reheating.

In the use of compressed air to operate engines, pumps, rock drills or other apparatus, it is advisable, though not necessary, to heat the air just previous to its entrance to the machine.

Reheating means the warming up of the air by some means, thus increasing its

volume to a degree which depends upon the amount of heat imparted to the air.

The reason for reheating is obvious when it is remembered that air, like other gases, when expanding produces a considerable fall in temperature. In ordinary practice with the compressed air at 60 degrees and a pressure of about 70 pounds exhaust temperatures ranging from 5 degrees to 140 degrees F. result, the variations being caused by the conditions of each case.

All compressed air such as is used in mining and quarrying undertakings contains more or less moisture, depending on the time of the year, the geographical position of the plant, and the location of the compressor inlet. No difficulty is experienced from this cause, but in winter, or in case the expansion is carried to a very low point, as is usually the case with engines, freezing of the moisture in the exhaust ports is apt to occur. Reheating to prevent this freezing is often necessary, but if done for this alone very little economy is effected.

Two avoid freezing two methods are generally employed, the most common being the spraying of water into the air pipe—sometimes before the air enters the apparatus, and at other times into the exhaust pipe. This water heating method is applicable to practically every case, but has economical limitations.

A second form consists in using steam in exactly the same way, but this method of reheating must naturally be restricted to a considerable extent, because it is seldom possible to obtain steam for this purpose, as the reheating must be done in out-of-the-way places, as in mines and in open work covering a considerable area.

By far the most satisfactory system is to use a special reheater designed for the purpose, one capable of heating the air to from 300 degrees to 500 degrees F., although from 250 degrees to 350 degrees may be taken as the usual working temperature obtained in practice.

This system absolutely prevents freezing and at the same time increases the efficiency of the equipment to a very large extent. In a compressed air installation the extravagance or economical working of the plant depends upon the amount of work done but the given amount of air by each machine. Reheating largely increases the volume of air and consequently gives a better efficiency. In practice the efficiency of an equipment employing reheaters of adequate sizes is improved as much as 25 to 40 per cent. over what could be obtained without them.

In figuring on reheaters it is usual to allow that one pound of coal will give from 8,000 to 10,000 B. T. U. to the air. As .0686. B. T. U.'s are required to raise the temperature of 1 lb. of air 1 degree F., it follows that one pound of coal burned in a reheater will heat one pound or 12.38 cu. ft. of free air to 11660 degrees or 33 lbs. (408 cu. ft.) to a final temperature of 350 degrees.

Generally speaking, one-sixth of the coal will be required for reheating which would be required to produce a given result if burned under a boiler and used to drive a large compressor.

As the reheater should invariably be placed near the machine to be operated, there is no special need for large sizes.

Notes.

The Standard Pneumatic Tool Company report that they have received more orders for Little Giant Pneumatic Tools during the past four weeks than in any other similar period since they started in business. Their European offices report some very large sales to ship yards and manufacturing concerns.

We acknowledge the receipt of an attractive pamphlet issued by the Christensen Engineering Co., of Milwaukee, Wis. The prime object of this pamphlet is to give a list of users of Air Brake outfits. To prevent monotony excellent illustrations are given, showing various forms of electric cars equipped with these brakes.

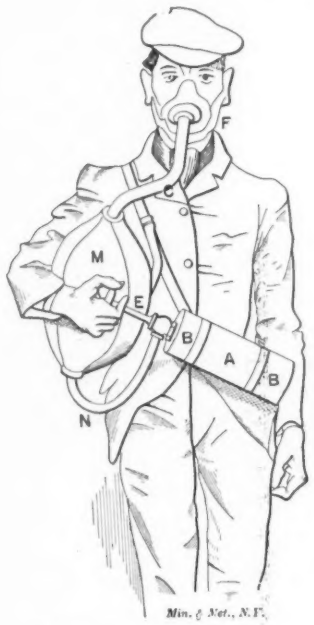
Two new compressed air cars for night service on the Union Traction lines have been shipped to Chicago, from Rome, N. Y. The cars were built at the works of the Compressed Air Company there and tried successfully on the local line before being sent to Chicago. They will be substituted for two of the cars which have been operated all night on the North Clark street line for the last two years and a half.

We have received from the International Correspondence Schools, Scranton, Pa., a

handsome brochure in two colors, announcing that to their already large curricula of one hundred courses they have added the studies of French, German and Spanish. Instruction in these subjects by the International system is conducted almost entirely by means of an Edison Standard Phonograph and the School's specially prepared Instruction Papers.

Interested parties will do well to send to the International Correspondence Schools for their free circular on Modern Languages, which contains a full account of how they teach these subjects by correspondence.

A description of the Walcher pneumatophor is given in connection with a lengthy article on the terrible explosion involving the death of 82 miners at the Universal Collieries, Shenghenydd, in the Aber Valley, South Wales. Mr. George Blake Walker, ex-president of the Midland In-



THE WALCHER GUARDIAN.

stitute of Mining Engineers, writes that England is practically without means of saving life when such catastrophes occur, and recommends the introduction of the Walcher pneumatophor, the invention of Herr von Walcher, Chief Director of the Archduke Frederick's mines at Teschen, Austria. The apparatus consists of an iron reservoir, A, carried on straps B, B, a tube, N, conveying air to the expansive bag, M; another tube conveying air from the bag to the mouthpiece, F; and a key, E, for regulating the supply of air to the bag.—*Col'y Guardian.*

Compressed air to prevent fires from sparking motors is the feature of the combined pneumatic-electric system designed by Hurd for fiery mines. Mr. Ernest K. Scott, in a recent paper presented to the Institution of Civil Engineers on coal-cutting by machinery, refers to it substantially as follows: The electric cables to the cutting machine are carried in 1½-inch iron pipes and a small supply of compressed air at a pressure of about 1 pound per square inch is sent along these pipes and allowed to escape into the working parts of the motor. The armature runs in a current of cool air, which tends to increase its current-carrying capacity, and at the same time prevent any explosive gases from reaching the working parts.

We have a circular of the "20th Century Moulding Machine," made and sold in Great Britain. This machine can be used with pneumatic, steam or hydraulic power, and they claim it produces a complete mould at one operation; that it is the most complete moulding machine on record, and one of the simplest. A base piece carries a piston, two or more vertical box guide columns, according to size of machine, and an outside guide column for the pattern plate, also a top-plate connected to the columns which serves to resist the pressure of piston when pressing the sand. The moulding boxes are fitted to slide on the guide columns and the pattern plate is pivoted on its guide column so that it may be swung out of the way or into position between the moulding boxes. This circular may be obtained by writing to No. 62 St. Vincent St., Glasgow.

For some time past Siemens & Halske have been experimenting on the Prussian Military Railroad with what may be called an electro-pneumatic brake, which is apparently a Westinghouse brake with

an addition of electrical apparatus by which the air pressure may be applied instantly and simultaneously on every car. The brakes may be applied pneumatically, as heretofore. At a meeting of the German Society of Mechanical Engineers, a Mr. Wagner, an engineer, who has been observing these experiments, spoke in enthusiastic terms of the results obtained, saying that it made the pneumatic brake applicable on the longest trains entirely without shock, and either gently or in full force; that all the air in the cylinders is made available for braking; that the braking can be graduated at will, and that when brakes have been let off they can be applied again instantly, which is often very desirable in entering stations.

The Shone system affords a means raised automatically from any given point to any other given point, the power emwhereby sewage or other liquids can be ployed being compressed air. Since its introduction in 1880, the application of this system has steadily advanced, and it is now in operation in all parts of the world. The system is applicable wherever the sewage cannot be carried by the force of gravitation to the desired point of discharge in a sanitary and satisfactory manner. It has been employed in many difficult instances and found satisfying to the utmost degree. An illustrated book of considerable interest has been issued on this subject. It explains every possible practice of the system, which is offered by the Shone Company, engineer, contractor and machinist, office and works at 445 West Forty-sixth street, Chicago. Inquirers are invited to correspond regarding any difficult proposition they may have to be solved. The book tells freely and entirely of the Shone system of sewerage and water supply and the various applications of the Shone Pneumatic Ejector.

To cool water by compressed air, take the cold, expanded air after it leaves a cylinder in which it has performed work, and conduct it through a pipe or coil of pipes immersed in the water, to be cooled before discharging it into the atmosphere. Another method is to discharge the air from the cylinder through a chamber holding vessels containing the water it is desired to cool. Ice can be made by either of the simple means suggested. Compresesd air which has not done work in a cylinder, but is simply released into the atmosphere through a valve, in expanding does its work in friction against the atmosphere into which it is discharged, and this energy is almost instantly coverted into heat. No cold can practically be produced in this manner. In expanding in a cylinder under load, the compressed air at the atmospheric temperature doing work uses up heat to a corresponding amount, which is not replaced through the walls of the cylinder. It has thus a temperature when discharged less than the temperature of the atmosphere, and proceeds to absorb heat from the nearest bodies containing it. These bodies thus have their temperature in turn reduced. This is the principle applied to cool water or make ice, as desired.

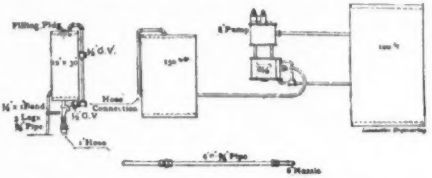
A system of air fans for cooling and ventilating passenger cars on railroads has been perfected by the Safety Car Heating and Lighting Company. A train on the New York Central has just been equipped with these fans and is now in service, while on a Pullman car running on the Erie Railroad from Jersey City to Tuxedo, there have been two in operation for some time. Two fans are placed in each car diagonally opposite and are made to revolve by means of compressed air, furnished by an additional air pump on the locomotive, the air thus supplied being conveyed the entire length of the train by means of the steam pipe which heretofore has served no purpose during the summer months. On each car is placed a storage tank into which the air is first carried and from there it is taken to the fans by means of a very small pipe. The fan weighs only about six pounds, and when this is compared with an electric fan weighing between 25 and 30 pounds, one of the advantages possessed by the air fans becomes at once apparent. Another superior feature is found in the fact that these fans not only agitate the air in the car, but introduce into it a large amount of cold fresh air as long as the fan is operated.

Referring to painting of locomotive tanks so that the paint will last and not scale, Mr. R. T. Shea, in Railway and Locomotive Engineering, advises the use of the Sand Blast and describes an

arrangement employed at the Aurora shops which has for two years been in successful operation.

The outfit in its finished form is clearly shown in the accompanying sketch, and this arrangement may prove of service to others who have experienced the same trouble in painting their locomotive tanks.

The size of the tank containing the sand may be modified to suit individual conditions. It will be noticed that the



ordinary locomotive air pump is used, the air passing into a receiver from which it is allowed to flow into the sand tank, as well as to the nozzle, thus insuring a steady flow of sand. The nozzle used is a piece of ordinary iron pipe, which is renewed as fast as worn. This has been found cheaper than the use of a hardened steel nozzle.

As the practical success of the sand blast depends very largely upon the impact energy of the sand, and hence its velocity, this apparatus uses a high pressure, the air being delivered at the nozzle at a pressure of from 100 to 150 pounds. The arrangement of the outfit is clearly shown in the illustration.

The work done by compressed air results in the using up of its heat units—that is to say, the air is colder at the end of an expansion than at the beginning. There is no difference in the quantity of work between expanding a given quantity of the air from 185 pounds gauge pressure down to 100 pounds gauge pressure and expanding the same quantity from 100 pounds pressure down to fifteen pounds, or the atmosphere. In either case exactly the same number of heat units that were in the air in the beginning must be used up. The higher the gauge pressure of the compressed air the larger the number of heat units it must lose in expanding to the atmospheric pressure. Practically these heat units are given to the compressed air by reheating before expanding. There is a mechanical limitation to reheating which makes the use of compressed air at very high pressure uneconomical. Liquid air represents the extreme of compression and the extreme conditions of uneconomical use. In experimental work no note has been taken of heat taken from the atmosphere during the expansion from liquid form down to working pressure, and claims of efficiency have been made which close analysis do not confirm. On large-scale commercial work the laboratory conditions cannot be maintained. The use of a compressed air plant exhausting back on itself, instead of the atmosphere, can not give any higher efficiency to the prime mover power, fuel or water, than exhaustion after work into the atmosphere.

The Northeastern Railway, of England, has an important installation of the Union Switch and Signal Co.'s electro-pneumatic system (Westinghouse) at Tyne Dock. The plant, which is already in hand, will consist of two cabins, the larger of which will contain an electro-pneumatic locking frame of 71 levers, and the other one of 35 levers, making a total of 106 levers. It is estimated that, if the old style of mechanical locking had been adopted for these cabins, about 250 levers would have been required to control the points and signals of the yard at Tyne Dock. In this connection *Transport* says: "It will be remembered that the first electro-pneumatic signaling plant—and also the first power plant of any kind—to be erected in this country was that installed at the White Chapel goods yard of the Great Eastern Railway. This was opened in January, 1899, and it has worked most satisfactorily ever since, although the working of the yard has never had any cessation either week-day or Sunday, day or night, since the date above mentioned. Moreover, the plant is in excellent condition, after these two and a half years' incessant work, and is in every way as good as on the day it was first put into operation. More recently, as readers of these columns will remember, the Lancashire & Yorkshire Railway Company gave an order for the installation of a 71 lever electro-pneumatic interlocking frame at the new station which they are now erecting at Bolton, and it is expected that the engineering works of this place will soon be sufficiently advanced to enable the erection of the signaling plant to be taken in hand."

An air compressor without a piston or any moving parts except valves has lately been described in the *Revue Universelle des Mines et de la Metallurgie*. It is the invention of M. Emile Gobbe, and has been tried with some success at the Monceau Company's blast furnace. The principal feature of the arrangement is an explosion chamber, the outlet of which leads to a chimney. A throttled valve which tends to remain open by its own weight is introduced between the chimney and the explosion chamber. Two conduits, one for gas, and the other for air, lead to this chamber. At some distance from the points at which they enter the combustion chamber, each conduit is provided with an inlet and an outlet valve, the latter communicating respectively with the receivers for compressed air and compressed gas. A draught having in any suitable way been started up the chimney of the plant, charges of air and gas are drawn in and mix in the combustion chamber. The mixture is then fired by an electric spark. The explosion closes the valve to the chimney and forces a portion of the air and gas back along their respective conduit pipes and through the discharge valves into their receivers. When the pressure falls sufficiently, the valve at the base of the chimney opens automatically again, and a fresh charge is drawn in and the action is repeated as before. In the experimental plant erected at Monceau, the explosions followed each other at the rate of twelve to fourteen per minute; but the plant proved to be in need of considerable modifications if satisfactory working was to be obtained. In a laboratory apparatus since constructed and designed to work with town in place of blast-furnace gas, good results have been obtained in the matter of regularity of working, and the inventor claims that with a large plant carefully designed very considerable economy could be relied on, and the capital cost would be extremely small.—*American Machinist.*

The August 22d issue of the *American Machinist* discusses editorially the subject of a Union Engineering Society House, to be located in New York City, and strongly advocates the consolidation of all of the leading national engineering societies, so far as the establishing of a common home is concerned.

For some time thoughtful members of these various societies have felt that supporting four or five different society houses imposed upon each society an expense which by proper arrangement between the societies could be materially reduced, and we are glad to see the idea take actual form.

There is no reason at all why the suggestion outlined in the editorial cannot be carried out. The plan is eminently feasible and is in line with the general business method of the day. The various libraries could be separately marked and shelved so as to remain distinct if this was desirable or could be combined and catalogued under one system. Various rooms could be reserved for the exclusive use of the separate societies and scheduled meetings could be arranged so that the large auditorium would be in use practically every night. Hotel accommodations could be provided with the probability of their being used regularly, and the fact that there was something going on at the Union House every evening would tend to draw a large number who now remain away from the society houses because they are rather lonely and uninteresting.

A printing office might be organized for the publication of all current matter, reports and notices, although the annual publications might, as now, be published by contract.

It would seem that such a Union Society House would become a sort of club, where the large number of engineers in and about New York and the many who are visiting here at all times would find congenial company.

We feel that the plan suggested is in the right direction and trust that it will receive the support which it deserves.

The construction of that part of the Greenwich Footway Tunnel formed by means of compressed air was recently completed and the Bridges Committee submitted a report by Messrs. Murray, Leslie and Macmorran, the medical officers appointed by the council to attend to cases of sickness among the men caused by working in compressed air. In the course of the report the medical officers say: "The most important and responsible task has been the selection of workmen altogether suitable for the work, and the most scrupulous care was exercised, both in the primary examinations of

all hands and in the re-examinations, at regular intervals, of the various gangs. During those examinations it was found that men who had previously worked in compressed air were by no means exempt from rejection. Very many of the old workmen were kept under constant surveillance, while many were rejected because a large percentage of them were found to have deviations from the normal in their heart action. Strangely enough, however, such cases as were provisionally passed, after a few days in compressed air no longed betrayed a trace of the previous peculiarity of the sounds of the heart. Again, within reasonable limits age should not influence the passing of an otherwise healthy man. Some of the best workmen are men well past their prime, and they have never been sick. On the other hand, any man showing moderately marked signs of sluggish organs, whether stomach, liver or kidneys (not necessarily diseased), also any one showing traces of gout or alcoholism, has been most strenously declined; and all suffering temporarily from any complaint have, on detection, been suspended until entirely recovered. To render security against the last named condition, a set of rules was drawn up and prominently posted refusing compensation to any workmen who went into compressed air suffering from any illness or from the effects of alcoholism, similarly to any who did not immediately report such illness and leave their names and addresses, in order that they might be seen soon as possible, and the nature of their complaints ascertained. In this way many claims were disallowed and some disproved.

"There were examined 122 men; there were rejected summarily 17 men, or 13.9 per cent. There were rejected after having worked for longer or shorter periods 6 men, or 5.7 per cent., making a total percentage of rejections of 18.8.

There were five cases of accident (only one serious); nine cases of illness, due to, or complicated by, the effects of compressed air (only three of which were allowed compensation); fifteen cases of illness not due to nor complicated by the effects of compressed air.

"During the construction of the tunnel an attempt was made to purify the air going into the tunnel, which has been productive of sufficiently good results to justify its use in other similar undertakings, viz., the absorption of excess of carbonic acid gas by screens of caustic soda, and an even better device, that of a blow-off tube from the shield where the gas most accumulates, ought to be adopted where practicable."

A visit was made by the members and associates of the Society of Engineers on Wednesday, June 12, to the air-compressing station for the Shone system of sewage ejection at the sewage disposal works, Erith, Kent, and the engineering works of Messrs. Fraser & Chalmers, which are also situated at Erith.

Among those present were Mr. Charles Mason, president; Messrs. Percy Griffith and D. B. Butler, vice-presidents; Messrs. J. Bernays and W. G. Pierce, past presidents; Mr. Maurice Wilson, member of Council, and Mr. Perry F. Nursey, secretary.

The Erith sewage disposal works, in which the air-compressor plant is working, are situated in Manor Road, Erith, at the east boundary of the district on the banks of the river Thames, and occupy about two acres of land. The gas-engine air-compressors are four in number, being two sets in duplicate. The first pair produce the compressed air for working the Shone ejectors for pumping the low-level sewage. These engines were made by Messrs. Crossley Bros., and comprise two Otto gas-engines and air cylinders, each to compress 158 cubic feet of free air per minute to 11 lbs. per square inch. The second pair produce the compressed air for the sludge pressing and for driving the mixing machinery. The gas cylinders indicate 25 horse-power each engine, and the air cylinders are capable of delivering 250 cubic feet of 100 lbs. per square inch air per hour. All four engines have automatic arrangements for throwing the air cylinders out of work when the working pressure in the receiver is reached. The second pair have this apparatus so arranged that the air cylinders can be entirely thrown out of work for any desired period. In addition to the foregoing, small air-pumps are fixed in each ejector chamber in order to pump out the condense water from time to time as it accumulates in the chambers. Dowson gas is used for the gas-engines, and is produced by the plant erected at the works by Messrs. Paisley, Welsh & Co.

The air main is laid at a depth of about 4 feet along the Manor Road, High Street,

West Street, Lower Road and Lower Abbey Road, to the several automatic ejectors situated in those roads, the last station being about three miles from the works. Following are particulars of station plant:

Station No.	Name of Station.	No. of Ejectors.	Discharging capacity of each Ejector in gallons per min.	Size of Air Supply. Inches.	Size of Air Exhaust Pipe. Inches.
No. 1	Appold Street	2	300	2½	2½
" 2	High Street..	2	200	2	2
" 3	Lower Road.	2	150	2	2
" 4	Station Road, Belvedere	2	150	2	2
" 5	Lower Abbey Road.....	2	50	2	2

The compressed air is delivered to the ejector stations through 4,600 feet run of 4-inch cast-iron socket pipe, jointed with yarn and lead, and 10,900 feet run of 3-inch similar pipe. All the pipes were tested to a pressure of 40 lbs. per square inch. The fall in pressure in one hour does not exceed 5 lbs. The compressed air-pipe is provided with stop valves close to each of the automatic valves, so that each of the ejectors can be repaired independently of the working of the others. Syphons for drawing off water are constructed at several points in the air main.

The Shone system of sewerage may be briefly described as a system of distributed stations for the lifting of sewage, worked from one central station by means of compressed air, whereby the whole drainage area is divided into a number of compact districts, each with its separate outfall and discharging station, the discharge from all the stations converging into one common main leading to the ultimate common outfall. The system is applicable wherever the sewage of a town or district requires to be lifted.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz.: all communications should be written on one side of the paper only; they should be short and to the point.

ED. COMPRESSED AIR:

Gentlemen: Enclosed please find check for $1.60, as renewal of subscription to COMPRESSED AIR for one year.

Hereafter kindly send the magazine to Mr. F. J. Philbrooks, our master mechanic, who has been greatly pleased with the book, especially on account of the valuable data which it contains, and which he has been able to apply successfully to our compressed plant at the mine.

I remain, very truly yours,

JOHN H. SCOTT.

Zaruma, Ecuador.

We have received the following letter from a subscriber in Oakland, California. Some of our readers may find the matter of interest:

Dear Sir: A few weeks back I noticed an article in your magazine treating upon the different uses of compressed air, and in one case you stated it was used in cleaning houses and especially adapted for the cleaning of carpets.

Will you kindly refer my letter, or send me the address of some firm or parties who manufacture a compressed air machine for the use of cleaning carpets. I am in the carpet business and wish to put up a carpet cleaning works, and if compressed air can be used for that purpose I would be glad to introduce it into my works. Any information you can send me regarding this machine will be very gratefully received.

Kindly address S. T. Allen, 805 11th street, Oakland. California.

COMPRESSED AIR:

We received the following questions from one of our correspondents and append answers which we trust will be of interest to our readers.

1. As air when being compressed heats, and when being expanded cools, why is it then when fanned that it cools a person or anything (when close to the fan)?

2. Could air be cooled in an air-tight tank by a fan in it?

3. Why does air feel so cool when in motion—as the wind?

It seems to me that the air in front of a fan, when fast in motion, is for a moment driven and compressed, and therefore is heated; while the air behind the fan is for a moment expanded, thereby being cooled. Please give your opinion on this, too.

Yours truly,

WILLIAM W. R. MAYER.

1. The reason the draught of air or air current, whether produced naturally or by fans, blowers or any artificial means cools, is that air is a poor conductor of heat, and when not in motion, forms a blanket which becomes warm and protects the object. When the air is in motion, this protecting blanket cannot be formed and the heat, as fast as given out, is conducted away by the moving air.

2. Air could not be cooled in an air-tight tank with a fan in it, and the probabilities are that it would be slightly warmed, the reason being that the air could not change and would be churned, the friction between the air and blades being sufficient to transform some of the mechanical energy into heat.

3. Is answered in No. 1.

Air in front of a fan is so slightly compressed that, for all purposes, there is no compression and therefore no heat accumulated. In the same way the air behind the fan is so slightly expanded that no cooling would be effected. The operation of the fan is, after it has been running for a little time, to create a series of currents in the air wherever it may be drawing in at the back and blowing out in front of the fan.

ED. COMPRESSED AIR:

Dear Sir: Am an interested reader and subscriber of your valuable publication, and thoroughly believe in compressed air in its many uses as a most valuable power transmitter, and am studying and working along the line for some time, and wish to ask you if you consider it practicable to pump water into an air-tight tank, compressing the air into the top of the tank, using the force to supply water for a suburban residence.

My plan was to connect a pressure regulator to the starting box of an electric motor so that when the pressure decreases the motor will start to pumping and at the set pressure be cut out again.

Of course it might be necessary at times to empty the tank in order to renew the air supply.

Your reply as to practicability of my plan and any suggestions you may see fit to make will be highly appreciated and if necessary remunerated by one of your interested and admiring subscribers.

JOHN E. T. NICKS.

As we understand this there is no reason why such a system could not be used, provided the amount of water to be handled was not very large. The tank would have to be absolutely tight and shaped to hold the air to prevent its passing out with the outgoing water.

To avert the possibility of the air all escaping from the tank the pump might be allowed to suck a little air into the water cylinder at intervals which air could be carried forward with the water to the tank where it could escape and collect at the top of the tank, thus making up for any leakage. Naturally this would cause the pump to work irregularly when so operating, but with a tight tank not too large a few minutes now and then would be ample to charge the tank. A good way, especially if the tank is any size, would be to have a small air compressor driven by an electric motor which could be run from time to time, started either automatically or by hand.

It would be perfectly feasible to use a pressure regulator to start your electric pump and a number of such regulators are already on the market, manufactured by concerns producing street railway air brakes.

It must not be imagined, however, that this system will be any more economical than that employing an open tank with an electric pump which is started or stopped at the proper time by a switch actuated by a float in the tank.

It requires a definite amount of work to raise a given quantity of water a definite height in a certain time and no apparatus can change this. The advantage of one device over another rests entirely in its economy of installation construction or operation or its simplicity and longer life. As we understand our correspondent the question of economy is not the issue, it being one of automatic control.

Starkville, Miss., Oct. 18, 1901.

Editor COMPRESSED AIR:

Dear Sir:—Will you please give me the information asked with this? Any other information you can give will be appreciated. Yours, &c.,

W. G. SCOTT.

Answer through next issue of COMPRESSED AIR, if possible.

Depth of well, 1,000 ft.; size of casing, 8 in. (air is used down); size of delivery

pipe, 4½ casing (no ex. air pipe); depth to water, 150 ft.; depth of delivery pipe in water, 60 ft.; duplex compressor, 12 x 14; duplex steam cylinder, 12 x 12; speed, 100 per minute; steam pipe, 3½ in.; distance from boiler, 30 ft.; steam pressure, 80 lbs.; no cut-off steam at full stroke; air pressure, 40 lbs.; water delivered at top of ground, 60 gal. per minute; head falls about 15 ft. while pumping.

First—What horse power is put into the steam cylinders?

Second—What horse power is delivered in water?

Third—About what horse power water should be got under the above conditions, if everything is working properly? (The compressors have spring controlled valves and they leak badly.)

Fourth—What would be the best arrangement for air and delivery pipes, and under the best conditions, what would probably be the possibilities of the well in water.

Fifth—What kind of oil should be used on compressors. W. G. S.

According to common practice in air lift installations, and if we understand your case, your well is certainly not doing what should be expected.

In the first place, as you do not clearly state to what height above the ground surface you are raising the water, we have assumed that it is discharging on a level with the ground surface.

With this it appears that you are raising water 150 + 15, or 165 feet, with a submergence of only 60 feet at best, whereas your submergence should be 60 % for maximum efficiency, or 247 feet.

To raise water to the assumed discharge point will require a pressure of about 125 lbs. In starting it would be necessary to raise a column of water 247 feet high, which at ½ lb. pressure for each foot lift means 125 lbs. When running, however, the water level drops 15 feet so that the water column is 232 feet, which calls for about 116 lbs. For each gallon of water raised under these conditions about 1.3 cu. ft. of free air will be required, or, approximately, 0.28 I. H. P. per gallon per minute.

The compressor you mention as "duplex." We presume this means two air cylinders, 14 x 12, and two steam cylinders 12 x 12. With steam at 100 lbs. this should give from 72 to 94 H. P. when running at 150 revolutions. Under these conditions its capacity would be 640 cubic feet of free air to a final pressure of 60 lbs. or about ½ the pressure necessary for maximum efficiency. From the dimensions given we would say that this compressor is not intended for a pressure over 60 lbs.

At 80 lbs. steam pressure and 100 revolutions an air pressure of 40 lbs. and a free air capacity of about 430 cu. ft. should be expected, possibly 40—45 H. P.

If you had 430 cu. ft. of free air raised to 125 lbs. at your disposal and a 60 % submergence, you should have a delivery of about 415 gallons of water per minute.

The trouble in your case seems to be that a proper arrangement of piping and compressor has not been made. As we read your letter it will be necessary to increase the submergence and change your compressor to one giving a pressure of 125 lbs.

Relative to oil, you should use a good, high grade, mineral, cylinder oil with a high flash point and one free from materials which will carbonize or cake. In our advertising pages reference will be found to special air compressor oils, of which several brands can be found in the market.

U. S. PATENTS GRANTED SEPT. 1901.

Specially prepared for COMPRESSED AIR.

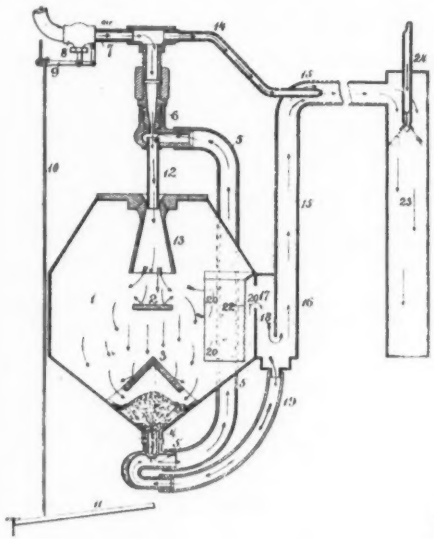
681,853. PNEUMATIC HOIST. William S. Halsey, Pittsburg, Pa. Filed April 5, 1901. Serial No. 54,512.

681,867. SAND-BLAST MACHINE. Arthur F. Bardwell, Stamford, Conn., assignor to the Yale & Towne Manufacturing Company, same place. Filed Jan. 24, 1896. Serial No. 576,724.

A sand-blast machine, the combination of the chamber which the work is manipulated, a sand-pipe connected with the bottom and top of said chamber, a compressed-air pipe connected with the said pipe for drawing sand through the same so as to cause it to

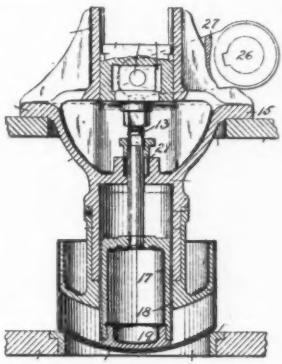
pass into the chamber, and suitable means for diffusing the compressed air whereby the sand is allowed to drop onto the work by gravity alone.

A sand-blast machine, the combination of a closed chamber in which the work is manipulated, said chamber being provided with an opening which is suitably connected with a discharge-flue, and suitable means for creating a draft through said flue so that air is withdrawn from said chamber to cause a current to pass across the face of the work to keep it free from dust.



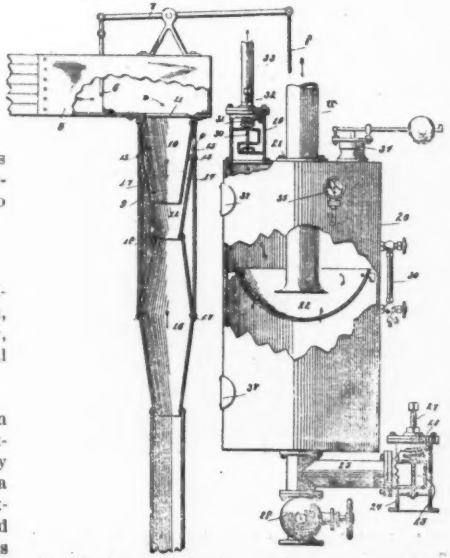
681,921. OUTLET-VALVE FOR AIR-COMPRESSORS. John S. Lewis, Youngstown, Ohio, assignor to William Tod & Company, same place. Filed Nov. 17, 1900. Serial No. 36,856.

An air-compressor, the combination of an outlet-valve having a hollow cylindrical extension and adapted to open automatically by excess of air-pressure in the cylinder, a stationary piston within said cylindrical extension, means for confining air between said stationary piston and the valve during its opening movement, and mechanism actuated by the valve-gear but out of contact with the inner cylindrical surface of the valve for forcing said valve to its seat.



682,773. PNEUMATICALLY-PROPELLED VEHICLE. William J. White, Cleveland, Ohio. Filed April 5, 1899. Serial No. 711,815.

682,811. HYDRAULIC AIR-COMPRESSOR. John Paterson, Nelson, Canada. Filed Nov. 3, 1900. Serial No. 35,385.



A hydraulic air-compressor comprising a closed tank forming a separating-chamber, a cross-sectionally-curved basin having an open top and secured in said tank, a water and air combining pipe leading through the tank and terminating centrally within the basin at a point below the open top thereof and leaving ample space for the water to flow freely into the basin, a water-drain pipe connected to the bottom of the tank and having a double valve, and an air-outlet pipe connected to the upper portion of the tank and also having a balanced double valve.

682,882. AIR-BRAKE COUPLING. Ole A. Ness, Zumbrota, Minn. Filed Jan. 11, 1901. Serial No. 42,907.

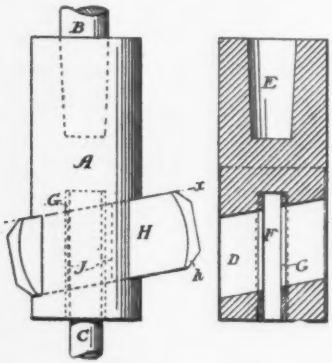
682,970. AIR-CAR. Adolf Brodbeck, Nashville, Tenn. Filed March 16, 1901. Serial No. 51,429.

682,98[illegible]. PNEUMATIC-DESPATCH-TUBE SYSTEM. Charles A. Gray, Kansas City, Kan., assignor to Gray Pneumatic Carrier Co., Kansas City, Mo. Filed April 5, 1901. Serial No. 54,563.

683,010. SYSTEM FOR UTILIZING LIQUID AIR OR OTHER GASES FOR PURPOSES OF REFRIGERATION AND POWER. Gabriel A. Bobrick, Los Angeles, Cal. Filed Nov. 8, 1900. Serial No. 35,880.

683,022. PNEUMATIC-DESPATCH-TUBE APPARATUS. James T. Cowley, Lowell, Mass., assignor to the American Pneumatic Service Company, Dover, Del. Filed Feb. 26, 1900. Serial No. 6,465.

683,127. ROCK-DRILL CHUCK. Frederick Long, Footscray, Victoria. Filed July 6, 1900. Serial No. 22,663.



A chuck having a bore for a bit-shank, and a keyway through the chuck inclined in relation to said bore and communicating with the chuck-bore, a bit-shank, and a key for the inclined keyway having an incision across its inner face parallel with the bore for the bit-shank and gradually deepening from the inner face of the key to a depth such that when the deepest part of the incision is beside the bore the key does not project into the bore and hence does not clamp the bit shank, said key however wedging the bit-shank when the key is driven forward.

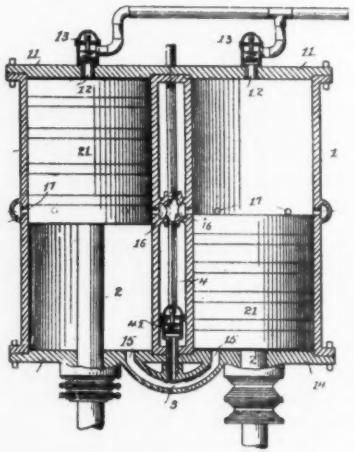
A chuck having tapered bore for piston-rod, bore for bit-shank and inclined keyway communicating with bit-shank bore, a bit-shank, and a key having an incision set at an angle on face of key and which is gradually deepened from the face-level of key.

683,140. TERMINAL FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. Otto S. Pike, Malden, Mass., assignor to the American Pneumatic Service Company, Dover, Del. Filed Oct. 19, 1900. Serial No. 33,612.

683,141. TERMINAL FOR PNEUMATIC-DESPATCH APPARATUS. Otto S. Pike, Malden, Mass., assignor to the American Pneumatic Service Company, Dover, Del. Filed Dec. 10, 1900. Serial No. 39,266.

683,158. COAL OR ROCK DRILL. Isaac Wantling, Peoria, Ill. Filed Feb. 16, 1901. Serial No. 47,664.

683,185. COMPRESSOR. William F. Singer, New York, N. Y., assignor to the Singer Automatic Ice Machine Company, Jersey City, N. J. Filed Nov. 15, 1900. Serial No. 36,614.



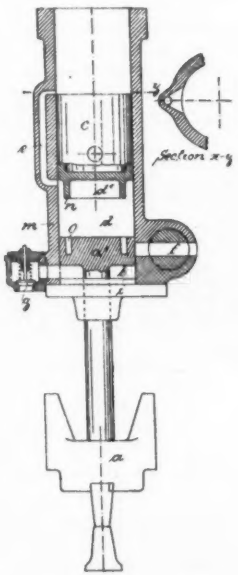
A single-acting pump and in combination two cylinders having parallel axes, annular

passage-ways surrounding said cylinders at substantially their middle points, a suction-tube connecting with said annular passage-ways, a plurality of ports connecting said annular passage-ways with said cylinder, said ports forming the only fluid-inlet openings into said cylinder, piston-heads arranged for alternate reciprocation and adapted to uncover said ports when retracted and to close same during the greater part of their stroke, a passage-way connecting said cylinders at the rear of said pistons, a relief-tube connecting said last-named passage-way with the suction and an automatic valve in said relief-tube.

683,215. AIR-VALVE. James P. Marsh, Chicago, Ill. Filed Jan. 25, 1896. Serial No. 576,841.

683,219. CAISSON. William H. McFadden, Pittsburg, Pa., assignor to the Consolidated Mining and Dredging Company, same place. Filed April 19, 1901. Serial No. 56,588.

683,374. PNEUMATIC HAMMER. Jean Beche, Huckeswagen, Germany. Filed June 13, 1901. Serial No. 64,445.



Pneumatic hammers, consisting of a cylinder with two pistons, one of which is moved upward and downward by the vacuum and air-pressure arising by the movement of the other piston, the arrangement of a channel within the cylinder-wall, the upper opening of which channel is situated directly above the spot at which the operating-piston stands in its lowest position, the other end of which is connected with the space between the two pistons.

Pneumatic hammers, the combination with a cylinder, two pistons situated within the same, a channel provided within the cylinder-wall, said channel being adapted to connect this space between the two pistons with the atmosphere in the moment in which the upper operating-piston stands on its lowest point, of an annular projection provided on the lower surface of the upper operating-piston, and an annular groove corresponding to this projection in the lower hammer-piston.

683,387. PNEUMATIC-DESPATCH-TUBE APPARATUS. James T. Cowley, Lowell, Mass., assignor to the Ameri an Pneumatic Service Company, Dover, Del. Filed Feb. 26, 1900. Serial No. 6,464.

683,400. SUBMARINE BOAT. John P. Holland, Newark, N. J., assignor to Electric Boat Company, of New Jersey. Filed April 26, 1900. Serial No. 14,482.

683,404. ROCK-DRILLING MACHINE. Manetho C. Jackson, Denver, Col., assignor, by direct and mesne assigments, to the Gardner Electric Drill and Machinery Company, same place. Filed Dec. 20, 1899. Serial No. 741,031.

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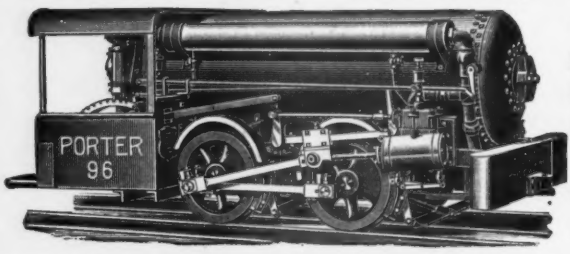

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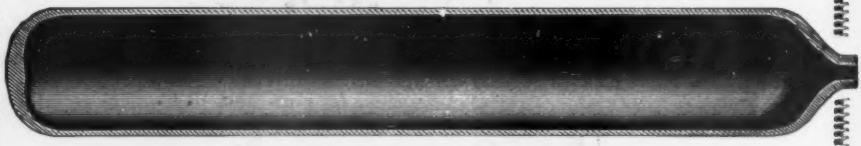

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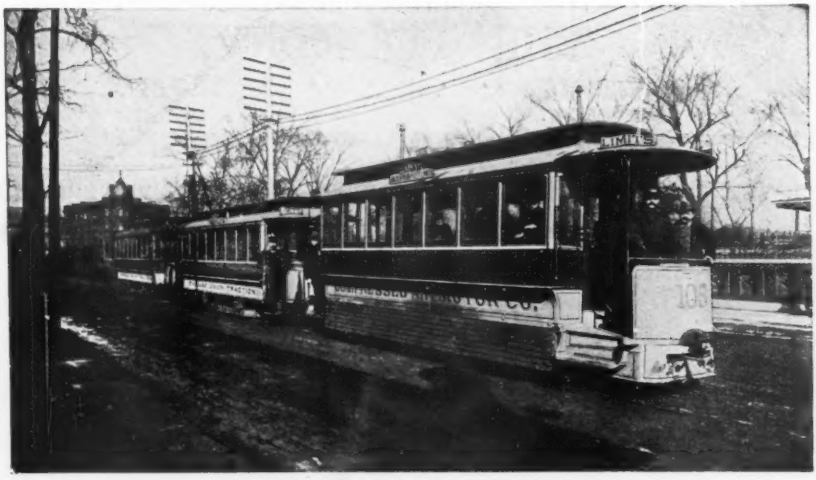

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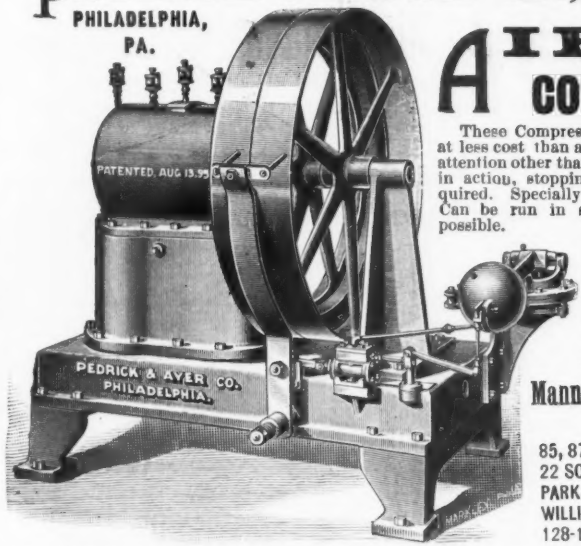

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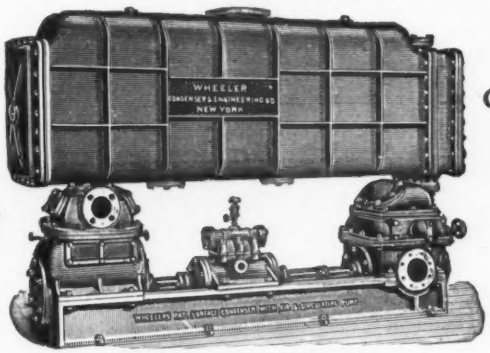

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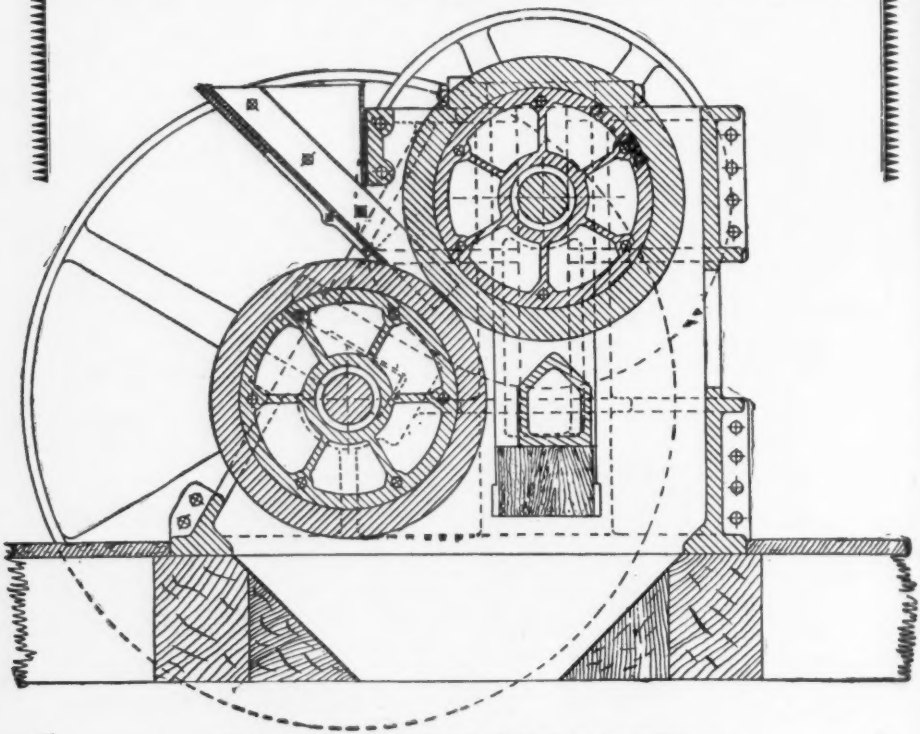

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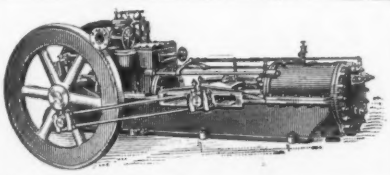

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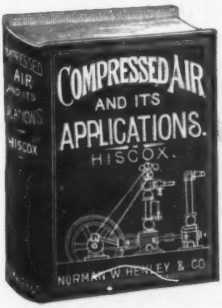

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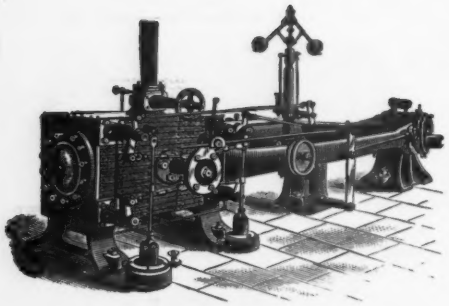

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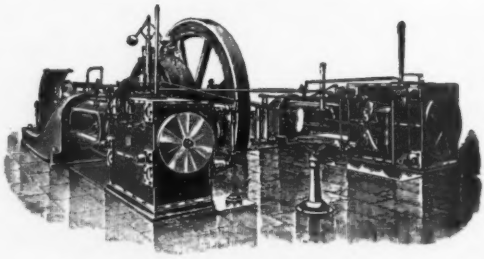

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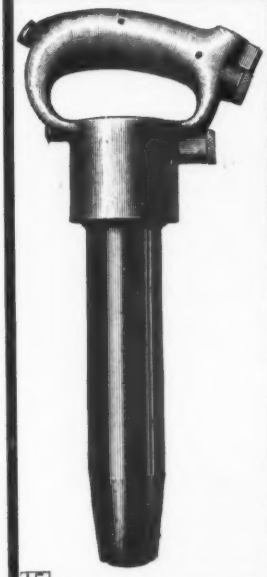

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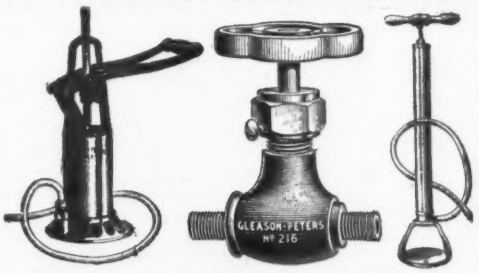

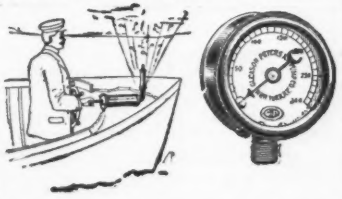

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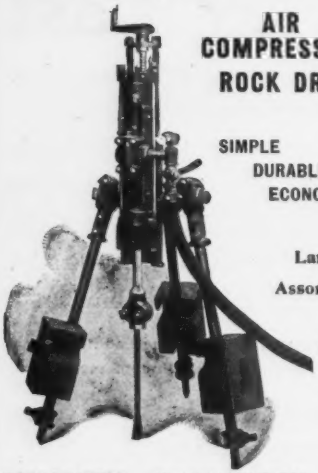

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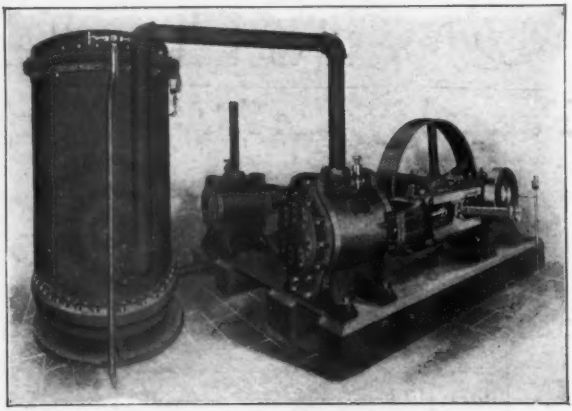

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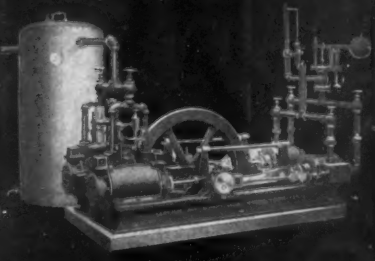

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